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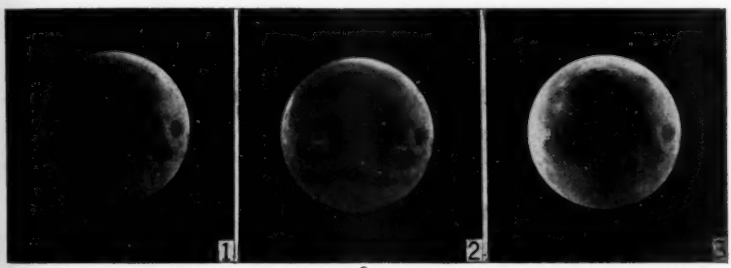
The Total Eclipse of the Moon 1942 August 25-26

By G. VAN BIESBROECK

This eclipse was visible here through its entirety although haze interfered part of the time. Shortly before the beginning of totality the shadow showed the characteristic copper-red color which diminished in intensity as the central phase approached. At the moment of the middle of the eclipse ($3^h\ 48^m.0$ U.T.) it was evident that the darkest part of the shadow was strongly decentered. Even at $3^h\ 53^m.3$ U.T. the center of the shadow was still appreciably east of the moon's center as illustrated by Figure 1 which is from a six second exposure with the 24-inch reflector. Figures 2 and 3 were similarly obtained at $3^h\ 58^m.1$ and $4^h\ 2^m.3$ with exposures of six and ten seconds, respectively. They show a surprising amount of detail on the surface.



TOTAL ECLIPSE OF THE MOON 1942 AUGUST 25-26 SHOWING RETARDATION OF THE APPARENT CENTRAL PHASE

Comparison of these images indicates that even at $3^h\ 58^m$ the center of the shadow was still behind the central phase while at $4^h\ 2^m$ the moon had just passed the middle. This would make $4^h\ 1^m$ the time of the apparent central phase, about 13 minutes later than the computed conjunction. Since the first and last contacts occurred exactly as predicted, as far as it is possible to estimate these times, it is evident that the intensity of the shadow was quite dissymetrical at the moment of the central phase of the eclipse which must have been due to unequal distribution of cloudy and clear sections of the earth's atmosphere. This is also borne out by the fact that towards the end of totality the reddish coloring was very much less pronounced than in the corresponding initial phase.

YERKES OBSERVATORY, WILLIAMS BAY, WISCONSIN, AUGUST 28, 1942.

Early American Astronomy

By H. B. RUMRILL

The cultivation of Astronomy in the colonies of North America was assuredly the privilege of the "chosen few," as was the pursuit of music and of the other fine arts. Even though there had been a plenitude of means to that end—which were almost wholly lacking—the times and the conditions of our earlier colonial life were not propitious for scientific or cultural advancement among the many. Franklin's studies and experiments in the physical sciences constituted a brilliant though later exception.

The beginnings of North American colonization along the eastern seaboard, during the first quarter of the seventeenth century, saw the invention of the telescope and with it the first authenticated nearer approach to the heavens in the history of mankind as accomplished by the discoveries of Galileo and his contemporaries. The settlements at Jamestown and Plymouth had little concern with these things, however, in the stress of establishing a new civilization and of creating new political alinements.

A more comprehensive treatment of the subject would extend its scope to the Astronomy of the still earlier settlements of the far southwest, but about which little is known. In all probability the dwellers in the pueblos paid attention to the stars in the enjoyment of a sky of exceptional clarity and must have become familiar with the motions of the Moon and of the planets. While this is largely conjectural, it is certain that the colonizers from Spain were not without fundamental knowledge of such things, at least sufficiently so to enable navigation to and from the New World, and would be likely to impart some of this knowledge to the peoples they conquered and sought to convert to Christianity.

The English-speaking world awaited the advent of Newton and Halley before men's minds were awakened to renewed consideration of the problems of the Universe, and this sort of knowledge was slow to take root on our side of the Atlantic. With the development, though, of suitable governmental functions and the growth of educational institutions in the colonies there came a measure of regard for Astronomy and Natural Philosophy, and after the middle of the eighteenth century might be found here and there a small telescope, usually a Gregorian reflector or, in the later colonial period, an achromatic refractor; but both were expensive rarities. These instruments were of English manufacture, and probably none were made in America until late in the career of David Rittenhouse (1732-1796), whose mechanical genius and knowledge of optics were occasionally turned in this direction.

It follows that of even primitive observatories there was doubtless

none until Rittenhouse erected a small one, primarily for the purpose of observing the transit of Venus on June 3, 1769. This was located at his home in the little hamlet of Norriton, then a part of Philadelphia County, Pennsylvania; now included in Norriton Township, Montgomery County, near the present city of Norristown, on the Schuylkill River. It was known simply as "Norriton Observatory." There seems to be little trustworthy record of the observatory beyond the mere fact of its existence, and an extant picture in Bean's *History of Montgomery County* (resembling a barn with openings cut in the slanting roof) is of uncertain origin. Nothing remains of the "observatory."

The latter is also true of another observatory built by Rittenhouse in later years, an octagonal structure opposite his residence at Seventh and Mulberry (now Arch) Streets, in the city of Philadelphia. The demolition of both does not speak well for any general interest in Astronomy, especially as books on the subject were nearly as uncommon as telescopes capable of showing celestial objects to any advantage. But with the gradual acquirement of instruments and books the attention to science that had begun to spread in England in the later eighteenth century, although still of slow growth in this country,—and very naturally restricted mostly to institutions of learning,—appears to have been otherwise confined to the observation of occasional phenomena of unusual interest.

In colonial times almanacs seem to have supplied all the astronomical information that was essential in the ordinary affairs of life. As an illustration, in the archives of the Pennsylvania Historical Society is a copy of one by Daniel Leeds, student in agriculture, entitled *Almanack for the year of Christian Account 1687, particularly respecting the Meridian and Latitude of Burlington* [*New Jersey*], *but may indifferently serve all places adjacent.*

This almanac was printed on a single sheet of large quarto size, by William Bradford "near Philadelphia in Pennsylvania," and shows under the caption "Vulgar Notes for the year 1687": Golden Number 16; Circle of the Sun 16; Epact 26; Dominical Letter B. The months are headed: The xi month, January; the xii month, February; the i month, March; etc. The times of the Sun's rising and setting are given for two days at the beginning and middle of each month, and the Moon's phases are shown to the nearest hour. Included are a few scattered items of interest, such as "longest day 14 hours 52"; "shortest day 9 hours 8 min."

Information regarding the tides is given briefly, as follows: "To find the time of high-water; Observe the time of high-water at any place on the day of the Moon's change, and add that time to the Moon's coming to the South any day in the year, and you have it."

Eclipse information is rather quaintly given under the caption "Of the Eclipses of the Luminaries this year, 1687," and is quoted in full

as follows:

> I find there will be two Eclipses happen this year, and they are both of the Sun. The first will be the first day of the third month about 7:00 in the morning and may be seen by us, if clouds hinder not; I judge it will be a great eclipse, especially to some people. The last will be October the 26th, not visible to us.
>
> Note, that by the observation of a Lunar Eclipse which happened the 11 of the 12 month 1681, I found the difference of meridians between London in England and Burlington with us to be 5 hours and about 20 minutes, so that it is noon at London 5 hours 20 minutes, before it is noon with us. But because some navigators made the difference more, I desire to be excused, if the observations were not exactly made, because I had no instruments suitable.

The "Almanack" closes with the following bit of verse:

> Mend, modest Reader, what thou findst amiss,
> But let the Author know what fault it is.
> All men have err'd since Adam first transgrest.
> If I commit no Faults I'm one o' th' best.
> But here my Comfort is, though I offend,
> I to my Faults can quickly put an END.

During the quarter of a century from 1732 to 1757 Franklin's *Poor Richard's Almanac* seems likewise to have furnished all that was necessary for common requirements in the way of astronomical data. In one of these its author naively remarked:

> You must excuse me dear reader that I afford you no eclipses of the moon this year. The truth is I do not find they do you any good. When there is one you are apt in observing it to expose yourself too much and too long in the night air whereby great numbers of you catch cold, which was the case last year to my very great concern. However, if you will promise to take more care of yourselves you shall have a fine one to stare at the year after next.

The foregoing relates mostly to Practical Astronomy of a simple nature. The study of Descriptive Astronomy had hardly begun due to the dearth of instruments of sufficient power to deal with it at all effectively. In England this branch of the science owed its real beginning almost entirely to the elder Herschel, and the writer has never heard of any telescopes made by him coming to America.

Whatever knowledge of Astronomy, therefore, was to be found in the later colonial period and during the earlier years of the republic was largely mathematical and theoretical in character, as witness the contents of certain papers appearing in the *Philosophical Memoirs* of the American Academy of Arts and Sciences, as follows:

1. A Method of finding the Altitude and Longitude of the nonagesimal Degree of the Ecliptic; with an Appendix, containing Calculations from corresponding Astronomical Observations, for determining the Difference of Meridians between Harvard-Hall, in the University of Cambridge, in the Commonwealth of Massachusetts, and the Royal Observatories at Greenwich and Paris. In a letter from the Reverend Joseph Willard, President of the University, and Corresponding Secre-

tary of the American Academy of Arts and Sciences, to the Honorable James Bowdoin, LL.D., President of the Academy. August 4, 1783. 61 pp.

2. A Memoir on the Latitude of the University at Cambridge; with Observations of the Variation and Dip of the Magnetic Needle. By Samuel Williams, F.A.A., Hollis Professor of Mathematics and Natural Philosophy in the University.

(All these references preserve the capitalization, punctuation, etc., except italic type, as found in the originals.) The observations were made in 1782 and 1783. Professor Williams remarked at the outset:

> The latitude of Cambridge has generally been supposed to be 42° 25′ north. I cannot find how early, by what observer, or with what instruments it was determined. The earliest observations at Cambridge of which I can find any account, were those of eclipses made by Mr. Thomas Brattle, mentioned in the Philosophical Transactions for 1704, No. 292, p. 1630. The first of these was of a solar eclipse, June 12, 1694. And he there informs us, that in his calculations, the latitude of Boston was allowed to be 42° 25′. This has been universally received as the latitude ever since that time, and probably for many years before. As the ancient instruments belonging to the College were but small, I was desirous to examine this matter with all the accuracy I could. With this view I made the following observations. They were taken in the Philosophy-Chamber in Harvard-Hall, with an astronomical quadrant of two feet and a half radius, made by Sisson.

3: A Table of the Equations to equal Altitudes, for the Latitude of the University of Cambridge, 42° 23′ 28″ N., with an Account of its Construction and Use. By the Reverend Joseph Willard, President of the University.

4. Astronomical Observations, made in the State of Massachusetts. By Professor Williams.

These observations were as follows:

(1) An observation of a lunar eclipse, November 12, 1761, at Waltham.
(2) An observation of a lunar eclipse, March 17, 1764, at Waltham.
(3) An observation of a solar eclipse, November 6, 1771, at Bradford.
(4) An observation of a lunar eclipse, April 6, 1773, at Bradford.
(5) An observation of a lunar eclipse, July 30, 1776, at Bradford.
(6) An observation of a solar eclipse, June 24, 1778, at Bradford.
(7) An observation of a lunar eclipse, December 3, 1778, at Bradford.
(8) An observation of a lunar eclipse, and an emersion of Jupiter's second satellite, May 29, 1779, at Bradford.
(9) Observations of a solar eclipse, October 27, 1780, made on the east side of Long-Island, in Penobscot-Bay.

Regarding the latter, Professor Williams remarked that

> Though involved in all the calamities and distresses of a severe war, the government discovered all the attention and readiness to promote the cause of science, which could have been expected in the most peaceable and prosperous times; and passed a resolve, directing the Board of War to fit out the Lincoln galley to convey me to Penobscot, or any other part at the eastward, with such assistants as I should judge necessary. Accordingly, I embarked Ocober 9, with Mr. Stephen Sewall, Professor of the Oriental Languages, James Winthrop, Esq., Librarian, Fortescue Vernon, A.B., and Messrs, Atkins, Davis, Hall, Dawson, Rensalear, and

King, students in the University. We took with us an excellent clock, an astronomical quadrant of 2½ feet radius, made by Sisson, several telescopes, and such other apparatus as were necessary.

The instruments were further described as

A reflecting telescope of two feet focal length, made by Short, and a magnifying power of ninety times;

An achromatic telescope of 4 feet, made by Dollond, magnifying 40 times;

A reflecting telescope, made by Nairne, magnifying 55 times;

A reflecting telescope of 12 inches focus, made by Short, magnifying about 55 times.

(10) Observations of a lunar eclipse, November 11, 1780, at Cambridge.
(11) Observations of a lunar eclipse, March 29, 1782, at Cambridge.
(12) Observations of a solar eclipse, April 12, 1782, at Cambridge.
(13) Observations of a lunar eclipse, September 10, 1783, at Cambridge.

I. An observation of the transit of Venus over the sun, June 3, 1769, at Newbury.

II. An observation of the transit of Mercury over the sun, November 9, 1769, at Salem.

III. Observations of the transit of Mercury over the sun, November 12, 1782, at the University in Cambridge.

Professor Williams mentioned the instruments used in the last-named observations as

An achromatic telescope made by Nairne, with a magnifying power of 150;

A reflecting telescope fitted with an object-glass micrometer made by Short, with a magnifying power of 60; and

An astronomical clock made by Ellicott.

5. Some select Astronomical Observations made at Chelsea, Latitude 42° 25′ and 26″ in Time East of the University at Cambridge. By the Rev. Phillips Payson, F.A.A.

This observer made use of the phenomena of Jupiter's satellites in the determination of latitude and longitude, stating that

The glass used, is a reflecting telescope, made by Nairne, better than 2 feet in length, and magnifying about 55 times. In a clear air, it shows the satellites of Jupiter to be nearly of the bigness of stars of the first magnitude.

6. Observation of the Transit of Mercury over the Sun, November 12, 1782, at Ipswich. By the Reverend Manasseh Cutler, F.A.A., who said that a reflecting telescope was used, magnifying 45 times.

7. A Memoir, containing Observations of a Solar Eclipse, October 27, 1780, made at Beverly: Also of a Lunar Eclipse, March 29, 1782,—of a Solar Eclipse, April 12, and of the Transit of Mercury over the Sun's Disc, November 12, the same year, made at the President's House in Cambridge. By the Rev. Joseph Willard, President of the University.

In addition to a clock and a Hadley's octant, the instruments consisted of two reflecting telescopes by Mann, of London, magnifying 34 and 45 times, respectively, and an achromatic refractor of 3 feet, used by the Reverend Mr. Prince, of Salem, of which President Willard said that "its original magnifying power was 16½; but he increased it to

43 times, by taking out the third glass of the sliding-tube, and adding another eye-glass of about an inch focus."

The lower power of 16½ may be an error for a 36-inch telescope, which was possibly not its *focal* length, but it is fair to infer that experimental observational astronomy had its devotees then, as now. President Willard also stated that "Mr. Prince had fixed parallel hairs in his refractor, dividing the sun's disc into four equal parts, horizontally. These hairs, together with a vertical one in the center, assisted us much in settling the places of the spots."

In observing the lunar eclipse of March 29, 1782, President Willard used an achromatic refractor, with a magnifying power of 90, while his companion, Mr. Caleb Gannett, made use of a reflecting telescope, of about the same magnifying power. Accompanying the paper is a well executed copper plate, illustrating the transit of Mercury, November 12, 1782.

8. Observations of a Solar Eclipse, October 27, 1780, made at St. John's Island, by Messrs. Clarke and Wright.

The point of observation was Charlotte-town, on the island, "in the gulph of St. Laurence." The observations were reported to Caleb Gannett by Joseph Peters, of Halifax, Nova Scotia, and he stated that he was "assured by Mr. Pool, of Yarmouth-Jebouge-Harbour, on the western coast of this province, that the eclipse there was total for a momentary space."

9. Observations of a Solar Eclipse, October 27, 1780, made at the University in Cambridge. Communicated by Caleb Gannett, A.M., Rec. Sec. Amer. Acad.

10. An Observation of a Solar Eclipse, October 27, 1780, at Providence. By Joseph Brown, Esquire.

Mr. Brown recited that

> My apparatus for the observation of the solar eclipse was a three-foot reflecting telescope, with spirit levels; a small graduated semi-circle of about 4½ inches radius, and rack motions for taking altitudes; and a glass micrometer, fitted with rack motions, I believe of Dollond's construction, having a nonius graduated to 1/500 part of an inch; a reflecting telescope of near two feet; and a prospect glass of three feet four inches length, which I mounted on a convenient stand.

11. Observations of the Solar Eclipse of the 27th of October, 1780, made at Newport, Rhode-Island, by Mons. de Grandchain. Translated from the French, and communicated by the Reverend President Willard.

Grandchain stated that

> The clock which was made use of to obtain the times, had a compound pendulum-rod, made by Mons. Berthoud, a celebrated clock-maker at Paris. It was regulated many days before and after the observation, by corresponding altitudes, taken with a quadrant made by Ramsden, which was very good and very well divided.

12. An Account of the Observations made in Providence, in the State of Rhode-Island, of the Eclipse of the Sun, which happened the 23d day

of April, 1781. By Benjamin West, Esquire, F.A.A. Communicated by the Reverend President Willard.

The observations were greatly marred by cloud, yet careful micrometrical measures were made after the clouds disppeared a few minutes before the middle of the eclipse.

13. Account of the Transit of Mercury, observed at Cambridge, November 12, 1782. By James Winthrop, Esquire, F.A.A.

After referring to the observations as having been made at the house of the Reverend Professor Williams, Mr. Winthrop stated that

> The magnifying power of the reflecting telescope used in these observations, was 260. The elliptical appearance of the planet was observed by Mr. Williams as well as myself, at both passages over the Sun's limb; but I do not recollect to have seen it remarked of any former transit of this planet.

14. Observations of an Eclipse of the Moon, March 29, 1782, and of an Eclipse of the Sun, on the 12th of April following, at Ipswich, Lat. 42° 38′ 30″. By the Reverend Manasseh Cutler, F.A.A.

The writer feels that the foregoing citations from the *Memoirs* are of sufficient interest and value in their relation to the history of Astronomy to warrant reproduction, especially as the old volume is now so rare, as well as being difficult to consult by the majority of amateur astronomers, as to make their perpetuation in this way doubtless welcome to those who may care to learn something of what these older observers did in their evident zeal in the pursuit of both practical and descriptive astronomy. No other books in the possession of the writer contain any reference to what was being done in those early days of American Astronomy, save the *Transactions of the American Philosophical Society,* published in Philadelphia, the first volume of which is of deep interest as recording some of the work of David Rittenhouse, whose genius in constructing instruments and making careful observations therewith has possibly not been sufficiently appreciated, as he was second only to his contemporary, Herschel, in ardor for astronomical research.

Here, again, many of the better known books are silent; yet Rittenhouse was the first in America who, by his innate love of thoroughness in observing, left a record not to be lightly regarded. One of his determinations of the solar parallax as 8″.805, by means of his own observations of the Transit of Venus in 1769, and their careful comparison with the Greenwich results, should really have marked an epoch in the history of Astronomy if it had received due recognition. Unless we relegate Rittenhouse's results as being somewhat affected by the element of chance (because, partly, of instrumental imperfections, and partly by the inadequacy of the transit of Venus method), *but not through ineptitude,* when compared with the numerous determinations of the solar parallax made during the following century, it is still remarkable that the value of 8″.805—so close to that now accepted—could have been arrived at thus independently.

The first paper in the *Transactions* is "A description of a new Orrery, planned and now nearly finished, by David Rittenhouse, A.M. of Norriton, in the County of Philadelphia. Communicated by Dr. Smith." [Not dated; probably 1768.] Of particuar interest is a paragraph reading

> When the machine is put in motion, by the turning of a winch, there are three indexes, which point out the hour of the day, the day of the month, and the year (according to the Julian account) answering to that situation of the heavenly bodies which it then represented; and so continually, for a period of 5000 years, either forward or backward.

The second paper is devoted to the calculations and projections of the transit of Venus, June 3, 1769. "Elements from Halley's Tables, for Lat. 40° N. and Long. 75 W. from Greenwich." A neatly engraved copper plate accompanied this paper.

Papers by the Reverend John Ewing and William Smith, D.D., Provost of the College of Philadelphia (afterward the University of Pennsylvania), followed, giving detailed accounts of the transit. In the latter paper reference is made to the Assembly having voted one hundred pounds sterling for the purchase of a reflecting telescope and micrometer for the City Observatory.

The instruments used at and adjacent to the Norriton Observatory are described in detail, as follows:

1. A Gregorian reflector about 2 f. focal length, with a Dollond's micrometer. This telescope hath four different magnifying powers, *viz.*, 55, 95, 130, and 200 times; by means of two tubes containing eye-glasses that magnify differently, and two small speculums of different focal distances. Made by Nairne. Used by Dr. Smith.
2. A refractor of 42 f. its magnifying power about 140. The glasses were sent from London with the large reflector, and belonged to Harvard College, New England; but as they did not arrive in time enough to be sent to that place before the Transit, they were fitted up here, by Mr. Rittenhouse; and used by Mr. Lukens.
3. Mr. Rittenhouse's refractor, with an object glass of 36 f. focus, and a convex eye-glass of 3 inches, magnifying about 144 times. Used by himself. "Both these refractors, as well as the reflector, were in most exquisite order."
4. An equal-altitude instrument; its telescope three and an half f. focal length, with two horizontal hairs, and a vertical one, in its focus, firmly supported on a stone pedestal, and easily adjusted to a plummet wire 4 feet in length, by 2 screws; one moving it in a North and South, the other in an East and West, direction.
5. A transit-telescope, fixed in the meridian on an axis with fine steel points; so that the hair in its focus can move in no other direction than along the meridian; in which are two marks South and North, about 330 yards distance each; to which it can be readily adjusted in a horizontal position by one screw, as it can in a vertical position by another screw.
6. An excellent time-piece, having for its pendulum-rod a flat steel bar, with a bob weighing about 12 lb. and vibrating in a small arch. It goes 8 days, does not stop when wound up, beats dead seconds, and is kept in motion by a weight of 5 pounds.

   "These three last articles were also Mr. Rittenhouse's property, and made by himself."
7. An astronomical quadrant, two and a half f. radius, made by Sisson, the property of the East Jersey Proprietors; under the care of the Right Hon. William, Earl of Stirling, Surveyor-General of that Province; from

> whom Mr. Lukens procured the use of it, and sent it up to Mr. Rittenhouse for ascertaining the latitude of the Observatory. Thus we were at length compleatly furnished with every instrument proper for our work. * * * * Mr. Rittenhouse "had fitted up the different instruments, and made a great number of observations, to ascertain the going of his time-piece, and to determine the latitude and longitude of his observatory." * * * *

The observers with the 36 feet and 42 feet refractors were obliged to lie on the ground (because of the Sun's altitude) with their heads bolstered up by the persons who assisted them.

Here followed Mr. Rittenhouse's account, dated Norriton, July 18, 1769, with a characteristically modest note, reading

> The enclosed is the best account I can give of the contacts, as I observed them; and of what I saw during the interval between them. I should be glad you would contract them, and also the other papers, into a smaller compass, as I would have done myself, if I had known how. I beg you would not copy anything merely because I have written it, but leave out what you think superfluous.

The introductory paragraph of Rittenhouse's account is quite entertaining, and is given in full:

> Early in November, 1768, I began to erect an observatory, agreeably to the resolutions of the American Philosophical Society; but, thro' various disappointments from workmen and weather, could not compleat it, till the middle of April, 1769. I had for some time expected the use of an equal-altitude instrument from Philadelphia; but finding I could not depend on having it, I fell to work, and made one of as simple a construction as I could. [No. 4 of the apparatus.] March 20 this instrument was finished, and put out of doors, the observatory not being yet ready.

The entire paper is of such absorbing interest that it would bear republishing in full, if space permitted. However, two short paragraphs are particularly worthy of reproduction, as follows:

> The Sun was so intensely bright on the day of the Transit, that instead of using the coloured glasses sent from England with the reflector, I put on a deeply-smoaked glass prepared by Mr. Lukens, which gave a much more beautiful, natural and well-defined appearance of the Sun's disk. The smoaked glass was fastened on the eye tube with a little bees-wax, and there was no occasion to change it during the whole day, as there was not the least cloud, or intermission of the Sun's splendor.
>
> Mr. Rittenhouse, in his previous projection had made the first external contact to be, June 3, $2^h\,11'$ for latitude 40° N. and longitude 5^h W. of Greenwich; on a supposition of the Sun's horizontal parallax being 8″. He happened to be very near the truth. For at $2^h\,10'\,33''$ mean time, the first external contact was at Norriton, lat. 40° 9′ 56″ N. and long. $5^h\,1'\,31''$ West. Other calculations made it generally from 6′ to 8′ later for the same latitude and longitude.

Rittenhouse wrote a fascinating description of the phenomena attending the first contact (part of which has been previously reprinted), which so evidences his accuracy as an observer and fidelity in relating exactly what he saw, that its entire reproduction herein may be of value because the original is not readily accessible.

> When the planet had advanced about one-third of its diameter on the Sun, as I was steadily viewing its progress, my sight was suddenly attracted by a beam of light, which broke through on that side of Venus yet off the Sun. Its figure was that of a broad-based pyramid; situated

> at about 40 or 45 degrees on the limb of Venus, from a line passing through her center and the Sun's, and to the left hand of that line as seen through my telescope, which inverted. About the same time, the Sun's light began to spread round Venus on each side, from the points where their limbs intersected each other.
>
> As Venus advanced, the point of the pyramid still grew lower, and its circular base wider, until it met the light which crept round from the points of intersection of the two limbs; so that when half the planet appeared on the Sun, the other half yet off the Sun was entirely surrounded by a semicircular light, best defined on the side next to the body of Venus, which continually grew brighter, till the time of the internal contact.
>
> Imagination cannot form anything more beautifully serene and quiet, than was the air during the whole time; nor did I ever see the Sun's limb more perfectly defined, or more free from any tremulous motion; to which his great altitude undoubtedly contributed much.

If the concluding paragraph needed corroboration, the writer might furnish it, as the solar definition at his location in Berwyn, some miles from Rittenhouse's site at Norriton, across the Chester Valley, is frequently so superb as to be beyond criticism. This statement rests on almost daily observation of the Sun during the past thirty years.

Associated with the astronomical story of colonial times is the work of David Rittenhouse in fixing the boundary lines between certain of the States, thereby leading to the settlement of disputes that might have had serious results. The boundary between Pennsylvania and Maryland was so accurately determined by Rittenhouse (with instruments of his own construction) that little or no change was made by the English surveyors, Charles Mason and Jeremiah Dixon, who began their work early in 1764, and who accorded courteous acknowledgment of Rittenhouse's calculations. The observations for the Mason-Dixon line were begun in Philadelphia in a small observatory the latitude of which was found to be 39° 56′ 29″.1 North. In the *Evening Public Ledger* of July 6, 1940, Mr. Joseph Jackson wrote that

> It was an unimpressive structure, built by a house carpenter on the back of a lot at what is now 30 South Street, then tenanted by Thomas Plumstead and Joseph Huddle.
>
> As is well known, from this point the two surveyors began to run a line across Pennsylvania, a line which was to become historic, although it only extended for a distance of 244 miles, which was within 36 miles of the whole distance to be run.
>
> The line would have been completed but for the interference by Indians, who made it plain that they would not permit these strange doings in their lands.

In the writer's possession is a rare copy of Halley's *Tables,* which appears to be the identical one used by Rittenhouse when preparing for the observation of the 1769 transit; at all events it was found with other books from Rittenhouse's library (one of which—a copy of Ferguson's *Astronomy*—contained his autograph) and shows evidence of usage by just such a skilled hand. It is dated 1749 and contained some loose sheets of closely written calculations and notes, evidently in Rittenhouse's handwriting, including a memorandum of an observation of Venus, reading

Yesterday Eavening the 5th June 1780 about half an hour before Sunsett. The planet Venus was visible with naked Eyes, very plain, when Sun was shining at that time.

The Latin title page is

EDMUNDI HALLEII
ASTRONOMI DUM VIVERET
REGII
TABULÆ
ASTRONOMICÆ
ACCEDUNT
DE USU TABULARUM PRÆCEPTA

The pagination of the Tables is in pen-and-ink, most probably by Rittenhouse, as the figures are similar to those in the calculations mentioned.

The *Philosophical Transactions* also include an account of the transit of Mercury, November 9, 1769; an account of the transit of Venus as observed at Cape Henlopen, in Delaware Bay; Benjamin West's observations of the same at Providence; Astronomer Royal Maskelyne's observations of the transit and of the solar eclipse the following day, at Greenwich; and a number of other important papers.

Although the story of Early American Astronomy might properly terminate with the close of the eighteenth century, it may be extended with references to some of the books which appeared in this country early in the nineteenth century, when increasing attention to Astronomy had also resulted in the reprinting of certain well-known books published in London.

Among the former is a small quarto entitled *Astronomical Recreations; or Sketches of the Relative Position and Mythological History of the Constellations,* by Jacob Green, published in Philadelphia in 1824. The preface states that "The plates have been faithfully reduced from those in the last edition of the magnificent Atlas of Bode, published in Germany a few years since, the extent and accuracy of which are known to every one familiar with the subject." These plates are beautifully engraved and colored, and while, as indicated in the title, the text includes some of the mythology so frequently found in popular astronomical literature, it is otherwise sufficiently original in character to rank as a very competent elementary Uranography.

Another of these older books, *Young Ladies' Astronomy,* by M. R. Bartlett, published in Utica, N. Y., in 1825, is of interest as including an outline of what was then known of Descriptive Astronomy. As might be expected, the planet Uranus is spoken of as "Herschel" or the "Georgian," following the example of English books of the period. These names are likewise used in Green's work, and both contain allusions to the old biblical chronology for the beginning of Creation, as well as to the Flood.

Among contemporary reprints of English books were the first American edition of George Adams's *Astronomy,* published at Whitehall, Phil-

adelphia, in 1800 (the first English edition of which appeared in 1766), and the fourth American edition of Thomas Keith's *Use of the Globes,* published in New York in 1826. The writer recently came into possession of a copy of the first American reprint of Ferguson's *Astronomy,* published in Philadelphia by Mathew Carey, 1806, and has noticed its republication there in 1817. All these reprints have become quite scarce, being infrequently met with in the old book stores, not less than a hundred of which have been visited in the endeavor to pick up items of interest.

Following the gradual emergence from colonial conditions, and contemporaneous with the later publications cited above, "honorable mention" should be made of the scholarly treatise on Astronomy written by John Gummere (1784-1844), of Haverford School, now Haverford College. The first edition was published at Philadelphia in 1822 by Kimber and Sharpless, followed by a number of editions from time to time, those after Gummere's death edited by Professor E. Otis Kendall, of the Central High School, Philadelphia. Its original publication preceded by many years the works of Denison Olmsted, of Yale College, and other early American writings on Astronomy, and antedating by twenty-seven years Sir John Herschel's famous *Outlines of Astronomy.*

Berwyn, Pennsylvania.

Solar Influence on Variations in Rainfall in the Interior of the United States

By EDWIN LINCOLN MOSELEY

In New York State, records of rainfall were kept more than a century ago at academies and other places; they are useful for comparison with the rainfall in recent years. Except in the vicinity of the ocean and along the Hudson and Mohawk rivers which receive moist winds from the ocean, the character of the rain in recent years—copious, deficient, or near normal—has shown a tendency to resemble that of about 90.4 years before. The same is true of Pennsylvania where, however, the number of early records is much smaller. 90.4 years is four times the magnetic sunspot period.

Data obtained from the study of tree-ring widths afford knowledge of rainfall in the growing season every year for more than three centuries past; a very few of the trees were growing at the time of Christopher Columbus. I have recently received from the Allegheny Forest Experiment Station in Pennsylvania sections from several old trees, among them two hemlocks which were growing before the discovery of America. In the year 1494 each of them formed a *very* narrow ring; this occurred in only one other year during the first two centuries of their growth. If these two trees had grown side by side we might suppose that some factor other than the lack of rain had caused their failure

to grow more than a very little that year, but they were far apart. Moreover, the only other trees which were growing at that early date, among the hundreds which I have studied, are two white oaks, one of which grew south of Marion, Ohio, the other about 100 miles northwest of Marion; each of them formed a *very* narrow ring in 1494. This leaves no reasonable doubt that, where these four trees grew, little rain fell in the growing season of 1494.

Ninety years later, 1584 was also a very dry year; we have sections from 17 trees that were growing then. The following year, 1585, was also dry, as were those following at 90- or 91-year intervals, 1675, 1766, 1856. Weather records as well as tree rings show that, over a wide area, 1856 was one of the driest years in the 19th century.

Both the Ohio and Michigan Academies of Science have published tables showing many series of wet years and of dry years, the dates in each series separated by 90-or 91-year intervals.* At the time of publication I had not studied a sufficient number of very old trees to include in this table any years prior to 1584, but later studies have enabled me to extend many of the series to still earlier dates.

Several wet years may occur in succession and the same is true of dry years. Measurements of the growth made by a large number of trees during the six years, 1870-75, and during the following nine years, 1876-84, show that in a majority of them the growth was more than one and a half times as great in the longer period. The same is true of six- and nine-year periods antedating these by 90 years, also 91 years earlier still. Other short periods of years have been measured with the same result—after 90 or 91 years wet periods are followed by wet periods, dry periods by dry periods.

Since this cycle of about 90.4 years is a multiple of the average sunspot period we might expect to find some association of light or heavy rain with the amount of the sun's surface covered by spots. If the relation were a simple one and if it applied to all parts of the earth, it would have been discovered long ago. Now that we know something about the amount of precipitation in Ohio and states nearby back as far as our knowledge of sunspot numbers extends, it is possible to point out certain relations between the two phenomena. These were published at some length with accompanying tables and graphs in an article "Sunspots and Tree Rings" in the *Journal of the Royal Astronomical Society of Canada,* November, 1941. Here we will mention some of them.

More rain usually falls between the sunspot minimum and the following maximum than between the maximum and the following minimum, allowance being made for difference in length of these intervals.

At the time of the minima, precipitation in the Ohio area is usually

*Long Time Forecasts of Ohio River Floods. *The Ohio Journal of Science,* Vol. 39, No. 4, July, 1939.

The Ninety-Year Precipitation Cycle. *Papers of the Michigan Academy of Science, Arts and Letters,* Vol. 25, 1939.

below average, often much below, but at some minima merely lower than for a few years preceding or following. When sunspot numbers continue to be low for several years in succession most of these years yield less than average rain.

Dry years are by no means limited to those of minimum or near minimum sunspots. Years with very high sunspot numbers do not give more rain, as a rule, than those whose sunspot numbers are only moderately high.

Because of the usefulness of the 90.4-year cycle in making long time forecasts of floods and droughts it is desirable to learn the geographical extent of its application. From Cass Lake in northern Minnesota, I have recently received cross sections of seven trees. Previously I had two from Cass Lake and one from Red Lake, 40 or 50 miles farther north. The rings of these trees show that the 90.4-year cycle does not apply to that region, or has so little application that it is not likely to be useful as a means of forecasting. In northern Minnesota there were dry periods, 1798-1802, 1808-1812, 1819-21, 1910-13, corresponding to some extent with prolonged periods of low sunspot numbers, but the years 1698-1701 were all wet although sunspot numbers were low. At some minima of short duration the Minnesota trees formed narrow rings, at others wide rings, and at others rings of about average width. Periods of rapid growth were not as a rule followed after an interval of ninety years by periods of rapid growth, nor were periods of slow growth usually followed after ninety years by periods of slow growth. So we may conclude that if solar influences bring about changes in the amount of precipitation in the Cass Lake region, they are different from those we find in the Ohio area.

There is some reason to think that the northernmost part of New York State, like northern Minnesota, is outside of the area where predictions can be made successfully on the basis of the 90.4-year cycle. My prediction that there would be a shortage of rain in New York State in the summer of 1939 came true for the whole state except the extreme north portion.*

In West Carroll Parish in the northeastern part of Louisiana, I studied the rings of 13 oak stumps in 1940. At or close to the dates of sunspot minima a majority of these trees formed narrow rings; at several of the minima the curtailment of growth was very pronounced. They show considerable repetition of dry years at 90-year intervals and also repetition of many of the wet years.

In Illinois and the states bordering the west side of the Mississippi River from southern Minnesota to Arkansas we do not know whether the 90-year cycle applies or not. Iowa is fortunate in having a number of stations where meteorological observations were recorded at an early date. The number of records there more than 90 years old will soon be

*See editorial page, *New York Times*, August 10, 1939.

sufficient to make clear whether this cycle applies to Iowa. If it does, these records will be useful in predicting floods and droughts in that state, as the older records in New York and Pennsylvania have been in those states.

By way of summary we may say that the 90.4-year cycle is useful in forecasting pronounced departures from the normal amount of precipitation in the region extending from southern Michigan to northeastern Louisiana and from Indiana to the vicinity of the Hudson and Delaware rivers, but not in northern Minnesota. In most of the states farther west than Indiana we do not yet know about its application.

UNIVERSITY MUSEUM, BOWLING GREEN, OHIO.

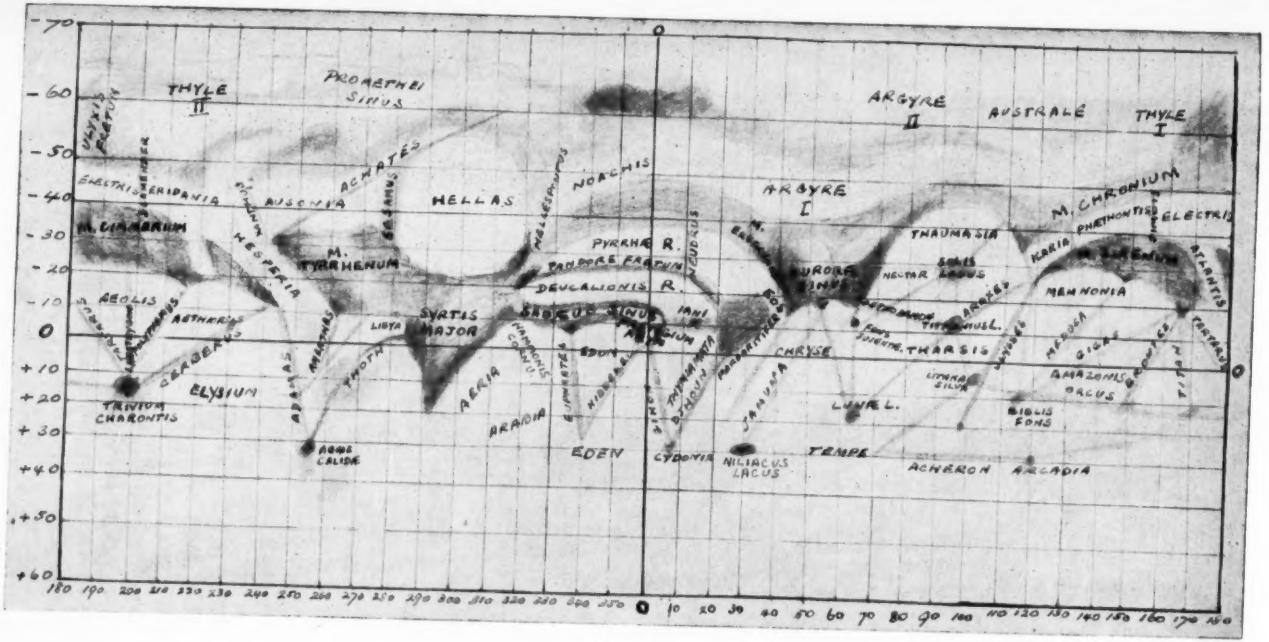
Mars in 1941

By ROBERT BARKER

Mars demands the highest technique of all the planets, the greatest patience, and the finest definition of telescope in order to reward the aspiring amateur. It is all essential that the telescope is one of exquisite definition, and a condition of equal importance is that the telescope is placed where conditions are favorable, a situation where steady clear seeing is obtained on average good nights. Size of aperture, say over 9 inches, is of secondary importance; a condition which Lowell emphasized as an axiom, and proved by his own action at Flagstaff, where the finest planetary seeing this world affords is obtained. His best Martian work was done with 18 inches, the usual powers for visual purposes being $\times$ 440 and $\times$ 617.

The writer's telescope is a 12.6-inch Calver equatorial, clock-driven reflector, and has a focal length of 120 inches; an instrument admirably adapted for lunar and planetary work in the uncertain climate of England. This great branch of real astronomy has been left to amateurs by the professional brigade (I have found, as a rule, professionals to be very poor observers), and a study of modern selenography and areography proves how the amateur, with his hard won instruments, has scored over the indifferent professional with his magnificent, easily acquired telescope.

The opposition of Mars in 1941 was very favorable here. Aided by our blackout skies, Mars was very clear (often too bright) and at a good altitude. The best seeing of fine detail was obtained when a thin mist prevailed. Then the glare of Mars was subdued, suspected detail became definite, and the contrast between the clear blue-green of the *Maria,* and the N. desertal areas, was emphasized. Faint oases then became distinct dusty spots, the hairline of a canal would flash into vision, and at the moments of best definition (when for a split second the air steadied into perfect seeing) the *Maria* immediately S. of the equator were resolved into minute, distinct areas; each varying from its



North

Chart of Mars in 1941 on Mercator's Projection

immediate neighbor, a vivid suggestion of large acreages of different crops. I, and others, have noticed the same effect on Venus in moments of perfect seeing.

From 34 selected observations (1941 July 11 to November 25) I have plotted a chart of Mars on Mercator's projection, reproduced here. Four individual drawings also appear, contrasted with 4 drawings by B. Burrell (Doncaster, Yorks) at corresponding longitudes which may form very interesting comparisons. We work 120 miles apart, and had no intercommunication during the period. Burrell's work is always of the highest standard, and no finer observer lives in our islands.

In what follows the figures in brackets refer to longitudes.

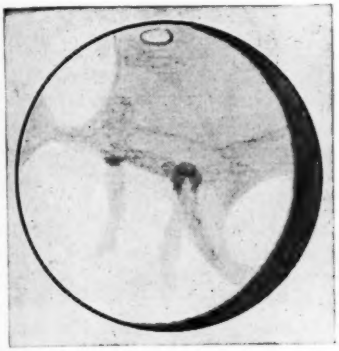
With reference to the chart, starting from longitude 180°, a dark streak high S, around this longitude was seen by me and other observers. It is Ulyxis Fretum, dividing Thyle I from Thyle II. The greyish areas surrounding South Polar Cap were well displayed, very diffuse, and chequered with faint, light streaks. N. of Electris, M. Cimmerium [200] was distinct, with the dark spot of Trivium Charontis extreme N., at which important oasis, Tartarus, Laestrygon, Polyphemus, and Cerberus meet. Hesperia [240] was clear as a divider of *Maria,* and Adamas met Thoth at Aquae Calidæ (sometimes termed Nubis Lacus), the dusty spot capping the curious Casius, not seen at this opposition, as the South Polar Cap was tilted earthwards.

The clear blue-green of M. Tyrrhenum [270] was always marked, with Hellas in white contrast. Further S. I caught Achates, never before to my knowledge seen here, and I had no knowledge of its existence. Syrtis Major [290] was again the most prominent feature, immediately N. of bright Hellas. Curiously, though Syrtis appeared distinct in outline to me, I find striking variations between my average drawing and those of other observers. Long. 0° area presents the finest picture Mars can offer, in beauty and delicacy.

Noachis, high S., was easy; so were Pyrrhæ and Deucalionis Regios, divided by the canal-like streak of Pandora Fretum. Sabæus Sinus, with its darker coastlines, ended at the famous "Forked Bay" (Fastigium Aryn), from which depended Gihon and Hiddekel, the latter appropriately meeting Euphrates at Eden. The gap dividing Fastigium Aryn from Margaritifer [30] was sometimes bridged by Iani F. From the tip of Margaritifer, Djhoun ran N. to meet Gihon. Eos [40] was a white gap, and Argyre I, higher S. was seen. Auroræ Sinus [60] showed its usual darker shade, relieved by light streaks, and some of us saw Fons Juventæ [65] readily.

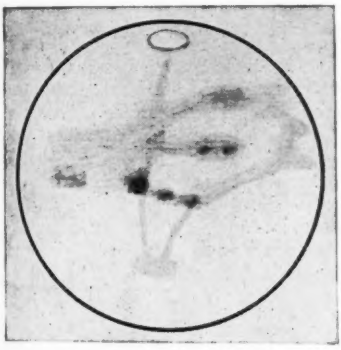
The region between 70° and 130° is the most difficult area. Here are few definite features, and when Solis Lacus is on the meridian, the first view merely reveals a few smudges on a blank background. Gradually the eye picks out the arch of M. Chronium [95] and shapes the blurs of Solis Lacus and Tithonius L. [95]. This apparition gave a wealth of crowded, very fine, difficult details here; for a cobweb of canals was

revealed to the puzzled eye. It was impossible to grasp, and truly record, this multitude of faint canals, so I merely drew the more prominent, all well known to experienced observers, such as Araxes and Ulysses, both issuing from the sharp "Beak of the Sirens"—M. Sirenum [130]. Here Orcus [140] showed strongly on its E.-W. course, with Acheron low N. M. Chronium [150] was always seen.



DEC. 1, 1941 $16^h\ 45^m$
$\omega = 358°$ B. BURRELL

OCT. 30, 1941 $21^h\ 30^m$
$\omega = 1°$ R. BARKER



OCT. 21, 1941 $20^h\ 20^m$
$\omega = 65°$ B. BURRELL

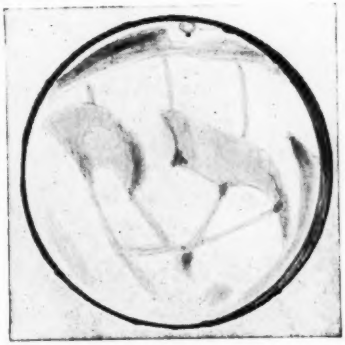
OCT. 23, 1941 $21^h\ 15^m$
$\omega = 61°$ R. BARKER

The light gap Atlantis [175] divided M. Sirenum and M. Cimmerium. From the N. caret of Sirenum, 4 prominent canals descended: Gigas, Brontes, Titan, Tartarus—all old friends of many years.

The drawings by Burrell and myself afford interesting comparisons, and due allowance must be made for observational errors and differ-

ences. Our skies are very uncertain, and although very good seeing often prevails, areas of different longitudes are recorded under greatly varying conditions, and the easiest feature is only *comparatively easy,* while the personal equation is always present, and has much influence over the most practiced observer.

Oct. 11, 1941 $23^h\ 50^m$
$\omega = 204°$ B. Burrell



Nov. 15, 1941 $20^h\ 30^m$
$\omega = 201°$ R. Barker

Oct. 1, 1941 $22^h\ 15^m$
$\omega = 269°$ B. Burrell

Sept. 29, 1941 $21^h\ 30^m$
$\omega = 275°$ R. Barker

With the above reservation in mind, it can be noted that many of the canals were not difficult features. Often (when the eye had tuned to the glare) the lineal markings were readily grasped; and as these lines seem to have affinity for seeking each other's society, and meeting at a far-off predestined junction, they could, as a rule, be traced from the caret which marked their departure to an oasis, generally low N. in the field. Only the more prominent can be seen with fair certainty, although

many can be glimpsed with positional uncertainty, as a faint cobwebby background.

The South Polar Cap was often very difficult after opposition. Sometimes the tiny white circle could only be glimpsed in a fleeting moment of steady seeing, surrounded by a hazy rim.

There is fair parallel between Burrell's 358° (central meridian) and my 1°. Both show Gihon and Euphrates, Pandore Fretum, Deucalionis and Pyrrhae Regios, and the white area of Hellas.

Burrell's 65° and my 61° are beginning a difficult area, and the parallel is closer than a first glance reveals. Solis Lacus was never distinct, (I suspected veiling cloud) and I was favored with a particularly good night, as the rest of my records near this meridian were poorer.

Burrell's 204° and my 201° show much agreement. The canals from M. Chronium (high S.) are given by both, the light regions of M. Sirenum and M. Cimmerium, and the great oasis Trivium Charontis, are recorded by both.

Burrell's 269° and my 275° show happy agreement in almost every feature, exception in the *size* of Syrtis Major.

The phenomenon of gemination was not seen by me, (Burrell records one as definite) and although double canals were suspected, I never, with certainty, was able to record one.

I usually employed a power of × 360, a beautiful eyepiece of exquisite definition, made for me by Dall on the Tolles' principle.

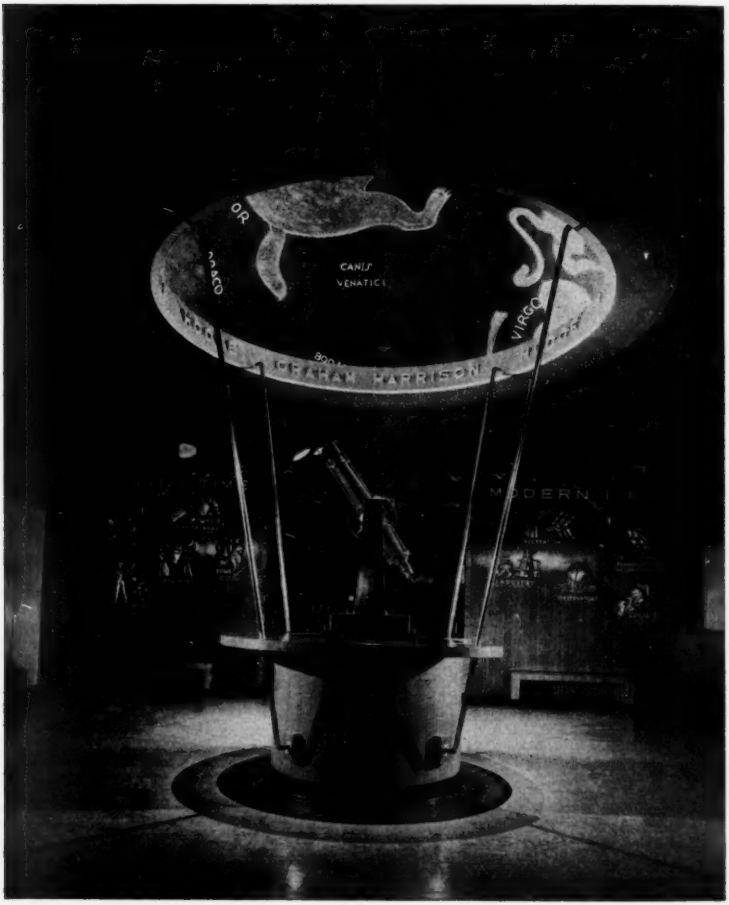
CHESHUNT, HERTS, ENGLAND.

The Story of Timekeeping through the Ages

The above title is the name given to the new permanent exhibit recently presented by the Elgin National Watch Company to the Museum of Science and Industry, Chicago. This exhibit gives permanency to the ideas presented by this same company in a temporary exhibit at the recent World's Fair in New York City. The opening of this exhibit was carried out with an elaborate ceremony last May. Mr. T. Albert Potter, the president of the company, made the formal presentation of the exhibit to the museum. Dr. Arthur H. Compton, well-known physicist of the University of Chicago, accepted the exhibit on behalf of the officials of the museum. More than 800 persons were present and the program of presentation was broadcast.

The principal features of the exhibit include a description of the method of securing time from the stars, models of ancient timetelling devices, a master time clock, a large-scale model of a watch in action, a collection of old and modern watches. One interested may here note

the improvement made in the methods of timekeeping from the earliest approximate devices to the modern mechanisms of great perfection and accuracy. The accompanying illustration shows the central feature of the exhibit.



THREE-INCH TRANSIT INSTRUMENT IN CENTER OF ELGIN TIME ROOM EXHIBIT AT THE MUSEUM OF SCIENCE AND INDUSTRY IN CHICAGO

The problem of securing accurate time is the phase of astronomical work with which the average person comes into closest contact. Such an exhibit, therefore, will undoubtedly be of continuing interest to visitors to the museum for many years to come.

Dates and the World Calendar

By JOHN L. ROBERTS

It seems to me that there are very important actuarial, statistical, and other reasons why a muddle of birthdays and of other dates should be avoided. The purpose of this article is to show how this muddle can be avoided if the change is made from the Gregorian calendar to the World calendar.

Assume for the sake of argument that the World calendar is now in force and that somebody asks the following question. When was M born and what is the date of his birthday the present year? If M was born July 4, 1888, according to the Gregorian calendar, it is convenient to say that he was born July 4, 1888, Gregorian calendar. We can calculate, by methods which will be explained later, that he was born on the 186th day of the year. If the World calendar had been in force during 1888, the 186th day of that year would have been July 3. Therefore, it is logical to say that M was born July 3, 1888, World calendar, and that his birthday in the present year is July 3, World calendar. It is obvious that the method of this paper does not furnish any knowledge of the days of the weeks.

It seems to me that there would be less mathematical confusion in the case of the World calendar if Leap-Year Day is called June 31 instead of June L and if Year-End Day is called December 31 instead of December Y. Suppose a person was born June 31, 1888, World calendar; it seems proper to say that his birthday is June 31 in leap years and is June 30 in other years; this would eliminate the absurdity that a person born on June 31 of some leap year has a birthday only once in four years.

The theory of the foregoing is complete with one exception; that theory does not provide any complete method of changing a date, Gregorian calendar to the equivalent date, World calendar. Three such methods seem desirable. The third method is for the populace; the other methods presuppose more education.

Suppose a person was born July 4, 1888, Gregorian calendar. On what date was he born according to the World calendar? This problem can be solved without using any tables and without presupposing any knowledge beyond arithmetic. Since the first six months of 1888, Gregorian calendar, contained 182 days, we deduce by adding 4 that July 4, Gregorian calendar was the 186th day of the year. Since the first six months of 1888, World calendar, contained 183 days and since 186 minus 183 is equal to 3, we deduce that the person was born July 3, 1888, World calendar. When applying the method of this paragraph, it is well to remember the following. In the case of the Gregorian calendar, the first quarter contains in each leap year 91 days and contains in

each other year 90 days; the second quarter contains 91 days; each of the third and fourth quarters contains 92 days. In the case of the World calendar, the second quarter contains in each leap year 92 days and contains in each other year 91 days; the fourth quarter contains 92 days; each of the first and third quarters contains 91 days.

Mathematicians can solve the problem of the preceding paragraph more quickly by the use of some simple algebra. If we assume that the person who was born July 4, 1888, Gregorian calendar, was born July x, World calendar, then x can be found by solving the following equation:

$$(91-91)+(92-91)+(x-4)=0.$$

The following table illustrates how tables can be constructed so that the populace can easily use them to change a date from one calendar to the equivalent date of the other calendar.

CHANGING DATES
Leap Years

——1st Quarter——		——2nd Quarter——		——3rd Quarter——	
Gregorian Calendar	World Calendar	Gregorian Calendar	World Calendar	Gregorian Calendar	World Calendar
Jan. 1	Jan. 1	Apr. 1	Apr. 1	July 2	July 1
2	2	.	.	.	.
3	3	.	.	.	.
4	4	30	30	.	.
5	5	May 1	31	31	30
6	6	2	May 1	Aug. 1	31
7	7	.	.	2	Aug. 1
.	.	.	.	.	.
8	8	.	.	.	.
.	.	31	30	.	.
.	.	June 1	June 1	31	30
.	.	.	.	Sept. 1	Sept. 1
Mar. 1	Feb. 30	.	.	.	.
2	Mar. 1	.	.	.	.
.	.	23	23	.	.
.	.	.	.		
.	.	24	24		
31	30	25	25		
		26	26		
		27	27		
		28	28		
		29	29		
		30	30		
		July 1	31		

In the above table most of the dates are omitted. No dates should be omitted in any table to be used by the populace; also the 4th Quarter should not be omitted. Also another table should be constructed for other years; in other words, for years which are not leap years. It might be possible to combine these two tables so that they are parts of one table. If a person wishes to use these tables to change a date according to the Gregorian calendar to the equivalent date according to the World calendar, it is merely necessary to find the date under the Gregorian calendar, and to find the equivalent date in the same horizon-

tal line under the World calendar. All people who use these tables should be warned not to use them to find the days of the weeks according to the Gregorian calendar.

28 Boody Street, Brunswick, Maine.

Errors in "Marvelous Voyages—IV"

By LAURENCE J. LAFLEUR

The list of errors which follows was compiled by Dr. Laurence J. Lafleur, the contributor of the paper, published in the August (1942) issue of this magazine, to which the errors pertain. As intimated previously we should be pleased to hear of any other errors in the paper which our readers might detect, or of any errors in the list of errors. Editor.

Errors in "Around the Moon"

1. Objects in the projectile would be hurled with tremendous force to the floor as the projectile leaves the gun, then, as it encounters atmospheric resistance, would be hurled to the roof.

2. If the projectile were moving, the fact would be immediately evident because neither the men nor any objects would have any apparent weight. This error is found throughout the story.

3. The sound of the explosion would be heard, unless the men were insensible. The rate of sound in air would refer to the air of the projectile which is moving with them.

4. The moon moves from west to east, not from east to west. The apparent east to west motion is the result of the earth's rotation, which would not concern the men in the projectile.

5. A satellite 5000 miles from the earth's surface would have a period of four hours and 48 minutes, not three hours and 20 minutes.

6. With the given orbit and period the satellite would be travelling 282 miles per hour, or about the same speed as the projectile at this point. Its direction from the projectile, given a close approach, must be about 45° from the vertical. Its phases could not therefore be full approaching and new receding, but gibbous approaching and thick crescent leaving.

7. Since it was seen from the window from which the moon was invisible, while both were approaching, it must be in retrograde motion, which would be worth remarking. Verne doesn't mention this fact.

8. In any case the satellite would be invisible because in eclipse. The projectile does not leave the earth's shadow until much later.

9. There is no reason to suppose that the development of life on the moon, if any, would be parallel to development here.

10. If parallel, a difference of thousands of years is much too low an

estimate. Thousands of years are insignificant in the astronomical and geological time-scales.

11. However fast they operated in opening the porthole, practically all the air would escape.

12. Space is in a sense cold, but more accurately it is without temperature, either hot or cold. It is the best insulation possible, and an approach to a vacuum is used by us in vacuum bottles to keep things warm. The amount of heat radiation will not be increased, therefore, by opening a porthole, and the only temperature loss will be that involved in the loss of air.

13. The projectile's velocity of escape will be very low. Hence Satellite's body would continue to recede indefinitely after it was thrown out.

14. There was hardly any period in the development of physical science when it would be appropriate to discourse dogmatically on the "atoms" of "ether."

15. An eclipse of the sun as seen from the moon would not be annular. At no time would a clear ring of sunlight be visible, although a rather irregular halo of reddish light could be expected.

16. Under no circumstances could the projectile reach the neutral point and stay there. The neutral point is a point of unstable equilibrium, and to reach it with zero velocity is infinitely improbable, as well as requiring infinite time. Even if attained, any perturbation would be sufficient to upset the equilibrium.

17. The neutral point travels around the earth with the moon. As the projectile does not revolve around the earth, occupation of this spot other than instantaneously is impossible.

18. And in any case the projectile will not even pass through the spot. This could only happen if the projectile travelled straight from a stationary earth to a stationary moon. Apart from the revolution of the moon, the trajectory itself is curved.

19. An excess of oxygen is described as producing the effects of drunkenness. The symptoms of drunkenness are produced by oxygen insufficiency, not overabundance.

20. Weights will be nil throughout the journey, not especially at the neutral point, which can't be reached anyway.

21. It is interesting to speculate on the proper procedure to drink a toast under the given conditions. Wine could not be poured, it could be shaken out of a bottle. Glasses would be quite unnecessary: globules of wine would form in the air and could then be sucked into the mouth. Even the process of swallowing would be curious.

22. The projectile would not turn its base towards the moon. In the absence of an atmosphere the lighter and heavier parts of the projectile would fall with equal velocity, leaving their relative positions unchanged.

23. Life on the moon similar to that on earth is improbable enough:

what then can be said for similar suppositions about Jupiter and the sun!

24. Other things being equal, the larger the planet, the smaller the life on it. The force of gravitation imposes a limit to the size of a species constructed in a given manner. A larger planet would have greater surface gravity, and lower maxima of size.

25. Even admitting Verne's hypothesis, mass would be proportioned to mass, height to diameter. Men of proportionate size would be a foot and a half tall, not less than one foot.

26. A meeting with a heavenly body is extremely unlikely. Two meetings in one ten-day trip strains the probabilities overmuch.

27. An object a mile and a quarter in diameter is hardly a meteor. It might be considered a planetoid or asteroid.

28. It would not be luminous in the moon's shadow.

29. There would be little likelihood of its exploding.

30. Its explosion would hardly save the travellers, but would, on the contrary, increase the chances of disastrous contact with some of the fragments.

31. The temperature of space would not be measureable. The thermometer would cool very gradually. (See error number 12.)

32. The temperature of space would be minus 273° C.

33. A liquid thermometer would not register extremely low temperatures.

34. The platform and springs would be pitifully inadequate to mitigate the fall to the moon.

35. The rocket principle, to be effective, would have to send off a mass comparable to the remaining mass of the projectile. Obviously this is not the case in the story.

36. If the rockets could not sensibly affect the velocity or course of the projectile when it was at its minimum velocity at the neutral point, how could it be really useful at a time of maximum velocity?

37. An elliptical orbit would take the projectile back to the same point *vis-a-vis* the stars, not the earth. In the three days intervening the earth and the neutral point would have moved about 40°.

38. A body moves in an ellipse under the influence of a single central mass. But in this case the influence of the earth is also great, equalling that of the moon at one point of the orbit. The orbit would therefore not be a simple conic section.

39. The objections to the fall through the atmosphere would be the same as those stated before concerning the rise through it.

40. The velocity of the fall would not be 56,000 feet per second. One-third of this velocity was lost to atmospheric friction in the rise, and would not be restored by the fall, which would, on the contrary, further reduce the velocity. In addition there would be a loss of velocity due to the firing of the rockets.

Planet Notes for November, 1942

By R. S. ZUG

NOTE: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from *The American Ephemeris and Nautical Almanac*.

Sun. Apparent positions of the sun for November 1 and December 1, respectively, are: $\alpha = 14^h\ 22^m.3$, $\delta = -14°\ 9'.4$; $\alpha = 16^h\ 25^m.6$, $\delta = -21°\ 40'.3$. The sun will pass from the constellation Libra to the constellation Scorpio on November 22. On November 29 it enters the constellation of Sagittarius.

Moon. Phenomena of the moon will occur as follows:

		h	m
Last Quarter	Nov. 1	6	18
New Moon	8	15	19
First Quarter	15	6	56
Full Moon	22	20	4
Perigee	Nov. 10	17	
Apogee	26	14	

Mercury. Mercury is a morning star during November, but inconspicuous except during the first few days of the month when it may be possible to locate the planet just before sunrise. Greatest western elongation occurred on October 26. Superior conjunction will occur December 1.

Venus. Venus will reach superior conjunction on November 16, 12^h, when the planet will be situated 32'.2 north of the center of the solar disk. The sun's angular semi-diameter being 16'.2 at the time, Venus will be situated 16' north of the northern limb of the sun. The angular diameter of the planet at that time will be 9".8 and its stellar magnitude —3.5. The distance from the earth of the planet at opposition will be 159,148,000 miles.

Mars. Mars will be a morning object during November, but rather too close to the sun to be distinguishable. By December 1, it will be $1^h\ 16^m$ west of the sun and in declination —17°.

Jupiter. Jupiter is now a conspicuous morning object, crossing the meridian about sunrise. The planet is moving near the eastern edge of the constellation Gemini. The apparent motion is easterly until November 12, after which it becomes retrograde.

Saturn. Saturn is a conspicuous morning star in the constellation Taurus. The planet is in retrograde motion, and, by the end of November, will be situated about 5° due north of Aldebaran.

Uranus. Uranus is approaching opposition and is favorably placed for observation in the constellation Taurus just east of the star ω Tauri. Apparent positions of the planet for November 1 and December 1, respectively, are: $\alpha = 4^h\ 6^m.3$, $\delta = +20°\ 42'.5$; $\alpha = 4^h\ 1^m.2$, $\delta = +20°\ 28'.7$.

Neptune. Neptune is a morning object, rising some four hours before the sun. Apparent positions of the planet for November 1 and December 1, respectively are: $\alpha = 12^h\ 5^m.7$, $\delta = +0°\ 48'.3$; $\alpha = 12^h\ 8^m.5$, $\delta = +0°\ 31'.2$.

Asteroid Notes

By HUGH S. RICE

Since the last writing of the Asteroid Notes we have observed the minor planet Vesta many times. Ever since the object was first picked up, it has been particularly easy to observe. One reason is that it retrograded to a certain point in Capricornus (as decribed before), which it reached September 9-10, and since that time has been moving in a direct sense, nearly retracing the former path in the sky.

On the night of August 25-26, Vesta was rather too near the full moon for easy observation, until the moon was in total eclipse; then we observed it with ease. For several days around the western stationary point in September, Vesta formed the tail of a huge arrow in the binocular field, the arrow being ¾° long and pointing northwest. At this time we observed from a point at Wilbraham, Mass., and the skies were essentially clear. Time and again we located the asteroid with the Zeiss 18x binoculars, held in the hand without any support, from indoors looking out—the window however being open—in about 5 minutes. We have also picked up comets in the same fashion.

Vesta is still in a good position for observation with small instruments during the autumn. On October 3, at 6:00 P.M., C.S.T., it is 6° nearly west of the star ψ Capricorni, or at a position-angle of 263° as used in double-star terminology, with magnitude 6.9. On October 14 at the same hour it is 3¾° exactly west of ψ, and the magnitude is 7.1. On October 29, at noon C.S.T., it is 2⅔° exactly south of 17 Capricorni, or 1½° north of ψ, magnitude 7.3. And on November 2, at 6:00 P.M., C.S.T., it is 3-1/6° north of ω Capricorni, magnitude 7.4. One can plot these points—falling almost on a straight line—on a star chart and thus follow the asteroid.

The asteroid headquarters being in Germany, we are unable at present to offer any news or reports of minor-planet activities as given out at this place.

Hayden Planetarium, American Museum of Natural History,
New York, N. Y., September 19, 1942.

Occultation Predictions for November, 1942

(Taken from the *American Ephemeris*)

Date 1942	Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
			h m	m	m	°	h m	m	m	°
OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′										
Nov. 1	54 Cnc	6.3	8 44.1	−1.8	+0.7	99	10 11.9	−2.0	−0.4	287
3	45 Leo	5.9	7 56.9	..	..	21	8 2.4	..	..	10
6	48 Vir *m*	6.5	10 31.6	−0.4	−0.6	146	11 27.4	−1.1	+1.5	262
17	27 Psc	5.1	20 51.0	−0.8	+1.8	73	22 0.8	−1.1	+1.7	242
17	29 Psc	5.2	23 6.1	−1.1	+2.2	35	0 17.1	−2.1	+0.3	272
18	4 Cet	6.3	3 4.7	−1.8	−1.1	96	4 8.9	−0.7	+1.0	212
18	5 Cet	6.3	3 24.1	−1.5	−0.8	87	4 32.3	−0.7	+0.5	222
19	ν Psc	4.7	23 41.5	−1.0	+2.1	53	0 57.9	−1.6	+1.2	254
23	318 B.Tau	5.7	22 57.5	+0.3	+1.6	71	23 54.6	−0.1	+1.4	262

Occultations Visible in Longitude +91° 0′, Latitude +40° 0′												
Nov. 1	54	Cnc	6.3	8	16.7	−1.1	+0.9	102	9	35.9	−1.5	+0.8	274
3	45	Leo	5.9	7	42.5	..	..	31	8	0.5	..	..	355
3	ρ	Leo	3.8	10	19.0	−1.3	+2.2	74	11	21.8	−1.3	−1.5	325
3	49	Leo	5.8	12	46.0	..	..	196	12	58.7	..	..	211
6	48	Vir *m*	6.5	10	32.6	+0.1	−2.1	169	11	4.1	−0.6	+3.3	233
10	166	B.Oph	6.5	23	21.7	−1.3	−1.8	121	0	18.1	−0.4	−0.5	240
17	29	Psc	5.2	22	43.5	−0.7	+2.8	23	23	37.2	−1.7	+0.4	290
18	4	Cet	6.3	2	27.6	−2.0	+0.4	76	3	47.8	−1.4	+0.9	226
18	5	Cet	6.3	2	50.8	−1.9	+0.5	69	4	12.0	−1.4	+0.5	234
19	ν	Psc	4.7	23	23.8	−0.4	+2.4	42	0	26.8	−1.2	+1.2	270
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′												
Nov. 1	54	Cnc	6.3	7	59.4	0.0	+1.0	95	9	2.0	−0.4	+1.0	275
1	o^1	Cnc	5.2	11	40.8	−1.9	+3.3	57	12	42.6	−1.9	−2.7	328
3	ρ	Leo	3.8	9	54.9	−0.1	+1.5	83	10	53.8	−0.6	0.0	305
13	ρ	Cap	5.0	23	50.9	−2.4	−1.1	130	0	41.5	−1.6	+2.4	205
18	4	Cet	6.3	1	32.7	−1.3	+2.1	50	2	51.2	−2.0	+1.0	257
18	5	Cet	6.3	1	57.0	−1.2	+2.3	40	3	13.5	−2.2	+0.7	265
25	19	B.Gem	6.2	14	6.0	−0.3	−2.6	133	15	0.6	−0.8	−0.2	239

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

For several years past the future of the American Meteor Society and particularly the disposition of the irreplaceable records on meteors now in my hands have been matters for serious consideration. On occasion, I have sought the advice of members, of others interested in the subject, and of scientists not directly involved, about these matters. It has not been easy to come to the wisest conclusions due largely to the unique *lack of organization* of our Society. Started by me in 1911, the first members were a small group of personal friends. It then gradually expanded until 1916. Later the first World War nearly ruined its activities, due largely to my own absence from its then-headquarters for almost a year. After 1921 it gradually revived and has had an increasingly successful career since. It, however, differs from all similar organizations in certain respects. First, though for some years there has been an annual fee of $1, this barely pays postage charges. Hence I have personally had to find funds for the running of our activities and publications. This has been possible in two ways. First, because the president at Agnes Scott College, Georgia, 1911-1914, the director, Dr. S. A. Mitchell of the Leander McCormick Observatory, University of Virginia, 1914-1928, and the authorities at the University of Pennsylvania since

1928, when I was appointed director of the Flower Observatory, have all permitted me office space and necessary time from my more regular duties to direct the work of our Society. Also in the latter two cases the observatories themselves often paid for the publication of the meteor results, issuing them as parts of their regular astronomical series.

Secondly, I have been able since 1916 to secure considerable grants for research in meteors and publication of the results from the J. Lawrence Smith Fund of the National Academy of Sciences, from the Penrose Fund of the American Philosophical Society, and from the Research Committee of the University of Pennsylvania. The sum total of these grants probably exceeded $5,000. I do not think up to the present that we have collected one-tenth that amount in dues.

The records of the Society have moved with me from Georgia to Virginia and then to Pennsylvania. To them I have added all I personally made and could collect from 1898 to 1911, which numbered well over six thousand observations, and of late older records donated to me from many sources. Due to the above facts, it has never seemed practicable to select or elect a group of regular officers. From time to time, I have appointed active observers as regional directors for a given state or region, who have had local authority to plan work and increase interest in meteoric astronomy. These have been changed by me when the person in question asked to be relieved, moved to another section, dropped out of the Society, or died. But the whole system is very elastic and, to be frank, has depended so far upon my ability to keep it going financially and furnish a proper place for our headquarters.

Realizing how dangerous it was for the Society so largely to depend upon the life or activity of any one person, I have entered into an agreement with the Franklin Institute of Philadelphia relative to the permanent preservation of our records. These are believed to form the most extensive collection in the world and, if meteor counts are included, should number perhaps half a million observations. Also I accepted recently a vice-presidency in the Society for Research on Meteorites, with this end in view, namely, that, when infirmity or death forces me to give up the direction of the American Meteor Society, then its present membership can at once become members of our sister Society and our activities continue without great change under the direction of its officers. This should prevent disintegration and best serve the cause of science. It will further be particularly easy because many persons are already members of both societies.

Philadelphia, while far from central geographically, is still central to the eastern part of the country, near many of our great universities, and is a city in which are located numerous centers of research and many education institutions of high rank. It is therefore a logical city to be made the depository of a valuable collection of scientific documents. The Franklin Institute building is very large and fireproof, centrally located, and the seat of many scientific activities, including some by groups of amateur astronomers. It also contains the Fels Planetarium and has a staff of professional astronomers attached thereto. So after careful consideration I decided that it was the proper place in which our records should be placed, and a legal document so stating was drawn up and signed with the full approbation of the authorities of the University of Pennsylvania, whom I first consulted. This approval was given because it did not seem wise to designate either of our two observatories for the following reasons. Flower Observatory is in a poor position due to the nearness of the city. Cook Observatory is in a

scarcely better position, but in any case its present site is temporary as we only keep the buildings and instruments where they are by the kind permission of Mrs. Gustavus W. Cook, the owner of the land, until other plans can be made for the combining of the two observatories on a new site at a distance from the city. Due to the war, there is no prospect of these plans being carried out for a long time. Meantime neither observatory has proper library facilities for the records and neither is fireproof. The University authorities therefore readily agreed with me that the Franklin Institute would be a more suitable place. That the Society may see that its rights were fully protected, the text of the agreement, somewhat abridged, follows.

AGREEMENT MADE THIS 10TH DAY OF AUGUST A.D., 1942, by and between Charles P. Olivier, . . . and the American Meteor Society . . ., parties of the first part and the Franklin Institute of Philadelphia . . . party of the second part, WITNESSETH THAT:

WHEREAS, Olivier and Society are the owners of certain records, maps, photographs, reprints, and other documents dealing with the subject of meteoric astronomy (hereinafter referred to as "Documents"), and

WHEREAS, Olivier and Society believe that a transfer of the title to and possession of Documents to Institute would be to the advantage of and for the interest of science; in order to insure for the future that said documents collected by Society and Olivier, its founder and president, shall always be available for scientific study in a place readily accessible and well-protected from the risk of accidental destruction;

NOW, THEREFORE, IT IS AGREED by and between the parties hereto in consideration of the premises as follows:

1. Olivier and Society agree to transfer and deliver to Institute the full and complete ownership and possession of said Documents at such future time as Olivier may determine to be for the advantage and best interest of science.

2. In the event that Olivier should die before the transfer and delivery of said Documents to Institute full title and ownership to such of said documents as may be owned by him at the time of his death will pass to Institute by . . . Will . . .

3. Institute agrees to provide a space in its Library or in some other suitable place for the storing and preserving of Documents in such manner that they may be kept in good condition and made available for immediate reference. Institute shall provide proper filing cabinet and/or shelves for this purpose.

4. Institute agrees that said Documents shall at all times consistent with the usual rules of Institute be available for study or examination by properly qualified persons, either professional or amateur scientists or students who produce satisfactory credentials, and further agrees that facilities shall be furnished in the Library to such persons for the purpose of such study or examination.

5. Institute agrees that the Director of the astronomical section of Institute may authorize the loan of said Documents to persons living either within or outside the City of Philadelphia, whose qualifications are satisfactory to the Institute, for periods not exceeding six months. In such cases, a careful inventory of such of said Documents as may be loaned shall be made and the same shall be examined and checked on their return.

IN WITNESS THEREOF, the corporate parties hereto have caused these presents

to be executed and the individual party hereto has affixed his hand and seal the day and year first written above.

CHARLES P. OLIVIER (Seal)
AMERICAN METEOR SOCIETY
By CHARLES P. OLIVIER, *President.*
THE FRANKLIN INSTITUTE OF PHILADELPHIA
By RICHARD W. LLOYD, *Vice-President.*

ANNUAL REPORT FOR 1941

This report usually has been published in the spring but this year was held up. The number of meteors reported reflects in some way the coming of war conditions to our country by the smaller total and by the fact that already the names of some of our observers are missing. However, when all conditions are taken into account, a good amount of work was done. Further, it will be noted that a larger per cent than usual of the meteors was plotted, and also that at least two groups of observers were quite active. It is still possible that even at this late date some of our regional directors have been too busy to report for 1941.

With regard to fireballs, if more than one observation of the same object arrive from different places, it is still counted as one fireball. Actually, therefore, as a good many had two or more observers the reports numbered many more than 114. Those fireballs in routine reports, when meteors were being regularly observed, also are not listed in the 114. Foreign ships had ceased almost entirely to report meteors to the Hydrographic Office during 1941, the officers being too busy looking for submarines, etc. This is the reason for a smaller total than usual. This year, unfortunately, the same is true also for American ships, so practically no reports can be expected from these sources.

Two observers reported most of the telescopic meteors: C. F. Fernald, Wilton, Maine, 36; B. S. Whitney, Observatory, University of Oklahoma, 17; Flower Observatory 7; H. Mason, Moorestown, New Jersey 2; total 64. Two beautiful photographs of bright meteors were obtained at Cook Observatory by R. K. Marshall, and superb photographs of a long-enduring meteor train were sent me from Alaska. I plan to publish a description of this later. Besides what has already appeared in Meteor Notes, I have done some work on determining radiants from the maps submitted during 1941, and, as time permits, the possible cases will be solved where the same meteor or fireball was observed from two or more stations. So while 1941 was by no means an outstanding year in the history of the A.M.S., still much excellent work was done by many people, and meteoric astronomy will profit by it. The records of three observers are outstanding: W. A. Borden 1256 meteors; Paul Anderson 1001 meteors; and Professor M. A. R. Khan 914 meteors—in all cases fully observed.

From now on those of us not too overwhelmed by war work, or not actually in the army or navy, where to their honor many of our best younger observers of 1941 now are, should try not to let the A.M.S. suffer as it did in the period 1917-1922. This can be accomplished by working at proper intervals showers or not, by not neglecting the few principal showers when they do come, and always reporting single bright meteors or fireballs casually seen. Also we commend the arousing of interest in others, either too young or too old or otherwise unable to do war work. It is an excellent way in which to direct their surplus energy and also build morale, as they would be unselfishly doing something really useful for science and hence for their country. I do not know myself what fresh duties will

be placed upon me when the regular session begins next month, but at the worst I will try to see that the most necessary activities of the Society, which I am responsible for, function as well as circumstances permit.

Observer and Station 1941	Nights	Meteors	Notes
Amateur Astronomers, Franklin Instiute, Philadelphia, Pennsylvania	10	649	21 P
Anderson, P., Beechwood, Michigan	54	1,001	P
Borden, W. A., Birmingham, Michigan	34	1,256	P
Champney, M., Jackson, Michigan	1	35	P
Dole, R. M., Cape Elizabeth, Maine	15	137	P
Ewart, J. L., Providence, Rhode Island	1	16	C
Feldman, R. C., E. Falls Church, Virginia	1	10	C
Graybill, A., Manheim, Pennsylvania	2	57	C
Haas, W. H., New Waterford, Ohio	11	164	P
Hahn, Mrs. J. A., Hagerstown, Maryland	1	42	C
Hamstrom, W. P., Philadelphia, Pennsylvania	1	10	C
Hewitt, G., Jackson, Michigan	4	74	P
Horton, W. P., Utica, New York	2	14	P
Jamison, A. W., Fayetteville, Arkansas	1	14	C
Jewitt, Miss M. L., Grandview, Tennessee	2	9	C
Johnson, M. C., Des Moines, Iowa	5	82	C
Johnson, W., Gridley, California	1	19	P
Khan, Professor M. A. R., Begumpet, India	51	914	P
Komaki, K., Kanaya, Japan	8	150	P
Levitt, I. M., Cook Observatory, Pennsylvania	1	22	2 Px
Louisville Astronomical Society, Louisville, Kentucky			
Landau, Mrs. M. S.	2	10	P
Landau, J.	2	12	C
Moore, J. S.	2	11	C
Humphries, M. S.	1	4	C
Kretschner,	1	3	C
Madison Astronomical Society, Madison, Wisconsin	1	53	C
Magruder, G. P., New York, New York	1	20	C
Marshall, R. K., Cook Observatory, Pennsylvania	3	28	P
Martin, H. S., East Norwalk, Connecticut	1	17	P
Milwaukee Astronomical Society, Milwaukee, Wis.	1	173	9 C
Newcomer, Mrs. A. R., Mount Joy, Pennsylvania	3	70	4 C
New Haven Group, New Haven, Connecticut			
Neale, J. J.	8	113	P
Short, Miss B.	3	100	Px
Scott, P.	3	65	Px
Thompson, R. M.	3	17	4 C
Rademacher, Mrs. G. C.	3	77	Px
Rademacher, Miss E.	1	14	C
Rademacher, Miss A.	1	16	C
Vosburgh, Miss M.	1	11	P
Furnald, Miss S.	1	10	P
Norton, H.	1	4	C
Corbett, M. T.	1	24	P
O'Connell, Miss H., Cynwyd, Pennsylvania	1	17	
Olivier, C. P., Flower Observatory, Pennsylvania	3	70	P
Persons, W. J., Kalamazoo, Michigan	2	23	P
Pietsch, L., Dallas, Texas	1	67	C
Pirsig, G., Blue Earth, Minnesota	1	18	P
Preucil, F., Joliet, Illinois	2	31	C
Smith College Observatory, Northampton, Mass.	1	33	5 P
Stone, W. R., Santa Barbara, Calif.	2	28	P
Stroud, W. G., Bromall, Pennsylvania	1	30	C
Topscott, Champaign, Illinois	30	246	P
Thompson, Miss B. J., Eugene, Oregon	2	20	C
Thompson, Mrs. F., Eugene, Oregon	1	10	C

Observer and Station 1941	Nights	Meteors	Notes
Wetherill, G., Upper Darby, Pennsylvania	1	40	P
Williams, P. B., New Orleans, Louisiana	2	41	2 C
Woodburn, J. J., Philadelphia, Pennsylvania	7	70	C
Casuals		43	
Total	307	6,314	
Fireballs		114	
Telescopic Meteors		64	
Photographs		3	
Grand total		6,495	

NOTE: In the table in the last column a number indicates how many persons took part in the observations; P that (most or all) meteors were plotted; Px that some meteors were plotted; C that only counts were made.

Flower Observatory of the University of Pennsylvania, Upper Darby, Pennsylvania, 1942, August 19.

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD
Department of Astronomy, University of California, Los Angeles

President of the Society: LINCOLN LA PAZ, Department of Mathematics, Ohio State University, Columbus

Secretary of the Society: C. H. CLEMINSHAW, Griffith Observatory, Los Angeles, and Department of Astronomy, University of Southern California, Los Angeles

J. G. Galle on the Pultusk, Poland, Meteoritic Shower

By LINCOLN LA PAZ
Department of Mathematics, Ohio State University, Columbus

The Pultusk, Poland, meteoritic shower of 1868 was one of the first for which careful calculations of the elements of the real path and the heliocentric orbit were made. The conclusions originally reached by J. G. Galle (1812-1910) have, in the past, been substantiated by reinvestigations made by several of the foremost authorities on meteoric astronomy. Recently, however, these conclusions have come under attack. Because the 45th *Jahresbericht und Abhandlungen der Schlesischen Gesellschaft für vaterländische Cultur,* in which the observational data employed by Galle and his supporters were published, is very difficult to secure, it has sometimes been necessary for his critics to rely on second-hand accounts of his work; *e.g.,* C. C. Wylie, in a paper on "The Orbit of the Pultusk Meteor" (*P. A.,* **48**, 1940), writes (p. 307), "Unfortunately for the purposes of this study, we were unable to secure a copy of Dr. Galle's original paper . . . We do have references to his paper, however, which give the more important results."

As any critique of Galle's results should be based certainly on the eyewitness accounts employed by him and should take cognizance of the repeated checks by which he sought to guard the accuracy of his work, it would seem highly desirable to make available to the present generation of meteoriticists the following translation of Galle's paper recently prepared by Mr. Walter H. Haas at the Ohio State University. Additional arguments in favor of publishing the Haas translation are easy to adduce: thus, Pultusk is the classical example of a

meteoritic shower of which the individuals are supposed to have been separated before striking the Earth's atmosphere, as would be the case in a swarm of young meteorites growing through the process of electrostatic accumulation described by A. Corlin (*cf.* L. La Paz, *C.S.R.M.*, **2**, 274-8, 1938-41; *P. A.*, **49**, 261-5, 1941); furthermore, the question of the number of indivduals falling in the Pultusk shower has been reopened quite recently and has led to an animated controversy between E. Stenz, L. J. Spencer, and F. A. Paneth (*cf.* also La Paz, *C.S.R.M.*, **2**, 235-43, 1938-41; *P. A.*, **49**, 41-9, 1941).

Concerning the Meteor Observed on January 30, 1868, which Fell through the Atmosphere as a Shower of Stones at Pultusk in the Kingdom of Poland*

By J. G. Galle [1812-1910]
Translated by Walter H. Haas
Department of Mathematics, Ohio State University, Columbus

(Communicated by Lincoln La Paz)

[ABSTRACT

This paper presents eyewitness accounts of the phenomena attending the fall of the Pultusk, Poland, meteorites. On the basis of the observational data thus provided, the real path and the heliocentric orbit pursued by the meteorites are determined.]

The luminous meteor observed for more than 60 miles round about, on January 30, [1868,] near 7 o'clock in the evening, which fell as a shower of stones upon a tract of land about a mile long near Pultusk in the Kingdom of Poland, presents so many problems to be considered that publication of the present material in several sections appears imperative: in part, because the investigations connected with it are of a very diverse nature; in part, in order to make the details more easily and more generally accessible and to make more easily possible mutual supplementation. In this respect the present paper limits itself principally to meteorological-astronomical questions and next to a compilation of the observations collected from Silesia, but with the addition of those from other regions which have up to now become known here. The essential part of the reports at hand is inserted *verbatim* to as large an extent as is feasible, in order that, for further or renewed investigation, where the same reports become necessary, the material will be found together as much as possible.

Observations at Breslau and at Danzig

The almost perpendicular line along which, as seen from central Silesia, the brightly shining and relatively long-lasting meteor appeared to drop down toward the horizon caused in Silesia as well as in Posen several illusions about the place of fall, which was supposed to be in the immediate vicinity. In particular, some days after January 30, it was announced telegraphically from Pleschen that,

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at several places in that region, pieces of a meteor[ite] had fallen. However, at the Imperial Sheriff's office itself, where inquiry into precisely this matter was under way, nothing had been learned about the fall of a meteoritic stone. Meanwhile, on February 6, the *Silesian Newspaper* included the report that a great shower of stones had occurred a few miles north of Warsaw and not far from the town of Pultusk; likewise, in the *Danzig Newspaper* there appeared an exact observation of the meteor by the astronomer Mr. Kayser, of the Natural Philosophical Association there. Since the possibility of obtaining more definite knowledge about the path of this large meteor through the atmosphere thus became apparent, I therefore permitted myself, in the *Silesian Newspaper* on February 7, to request observers in Silesia to send in their observations to the Observatory. After the lapse of 8 days, I had little hope of securing an exact astronomical observation, made with reference to the constellations through which the meteor flew, as in the case of the observation made at Danzig. However, my conjecture was refuted in a most pleasing manner. It very fortunately happened that here at Breslau itself, First Lieutenant v. Sichart, who is thoroughly familiar with the constellations, was crossing the small bridge over the Oder leading to the entrance of Holm Street at the precise moment of the phenomenon; consequently, not merely did he become attentive at the first flaring up of the meteor, but he also had a clear view along the Oder and across the University to the northeast, such as could not easily have been improved upon inside the city; hence, he could follow the phenomenon to the horizon (as far as the haziness of the sky allowed) and could immediately orient himself by reference to the constellations. These 2 astronomical observations at Danzig and at Breslau, respectively, could now form the chief basis of the calculation to be carried out; however, a large number of other reports, reaching me in a manner worthy of thanks, likewise were of great value and served in part for supplementing and in part for testing.

Some days after the public appeal, Mr. v. Sichart communicated to me a drawing made by him upon a star chart; and then, somewhat later still, a written report also, and it may be of value to introduce first of all these 2 important observations, especially the former, not previously published elsewhere. Mr. v. Sichart says: "I was walking almost due north and had, on my right, a horizon nowhere obstructed. A sudden brightness, similar to that produced by lightning, caused me to look upward, and I saw in the northeastern sky a bluish-green, extremely intense, luminous appearance slowly dropping downward in a vertical line. The sky was clear in the zenith, and, in addition, the constellations of Ursa Major and Gemini were visible. The remaining northeastern sky was clouded. Hence, I here saw the phenomenon only a second; it then disappeared behind the clouds and illuminated them, extending completely to the north and to the east like a really magnificent sea of fire, an appearance lasting actually 3 seconds; then suddenly a dark red, definitely bounded ball of fire, about half the diameter of the Moon, dropped through the clouds, followed by a thin red streak, and, preserving the same vertical direction, disappeared for me at a height of 4°-5° above the horizon without my perceiving either bursting or detonation. The intense luminosity of the meteor at its point of appearance in the atmosphere permitted neither its shape nor its size to be recognized, but the place where I first perceived it lay very close to κ Ursae Majoris, in the middle of a line joining the two stars α Ursae Majoris and β Geminorum, which were at nearly the same angular height. The path of the meteor was, therefore, also approximately perpendicular to the line connecting these stars. According to the star charts pre-

pared for mapping the Leonids the preceding year, by Dr. Heis in Münster, among which charts there is present one of the eastern sky for the horizon at 4^h sidereal time, one will not be much mistaken if one supposes that the path of the meteor also passed very close to the star θ Leonis, nearly vertically below κ Ursae Majoris. The entire phenomenon lasted probably 5 seconds and made an overwhelming impression."

Mr. Kayser reports about the Danzig observation in the newspaper there: "On January 30, in the evening, I was surprised by an extremely luminous meteor dropping from the southeast toward the east point when I was just in the act of closing the window situated in the same direction in the observation-room of the house of the Natural Philosophy Association. The meteor first revealed itself to me exactly at β Orionis (Rigel), moved in a straight line with very uniform intensity to Sirius, standing 8° above the horizon, and immediately burst at this place with a still more intensive flare and marked violence, showering sparks radially in all directions, but without a detonation. The color was throughout a beautiful green, similar to that of the Bengal lights. Scarcely 2 seconds could have elapsed from the beginning of the flight to the end of the phenomenon. It was otherwise similar to a shooting star and left behind a rapidly disappearing train, which impressed me as being spirally wound behind the point of bursting and which appeared to dissolve into single particles. I am of the opinion also that the meteor had no greater extent than perhaps only 4 minutes of arc [4′] and that, at the instant of bursting, the size was increased to half the diameter of the Moon by the separating pieces. The dazzling luster exceeded anything that was to be seen in the way of terrestrial or celestial lights. The stars shone but weakly because of the hazy condition of the air. Sirius was behind a thin layer of clouds, which on this day can be reckoned among the polar bands, and was faintly visible. The phenomenon occurred at $6^h\,49^m\,56^s$, Danzig time, according to the nearby chronometer. Since the place where the meteor burst corresponded to the azimuth 46° 8′, from south toward east, this event occurred on the line Neutrich-Christburg-Saalfeld-Neidenburg."

The Path Corresponding to the Danzig-Breslau Observations

On the basis of Mr. Kayser's report, the apparent path at Danzig, as established by 2 bright stars, leaves nothing to be wished for in regard to accuracy; in the case of the path as observed at Breslau, where only the mid-point between 2 distant bright stars could be used to mark the point of appearance and only the vertical line to indicate the direction of the path, the inaccuracy is somewhat greater and is presumably of the order of a few degrees.

I now took as the basis of my calculations Mr. v. Sichart's original drawing on Heis's star chart, not the slightly modified statements of the report written somewhat later, which is printed hereinbefore (altho the latter remains completely within the limits of admissible error). It here appeared advisable to assume as fixed only the 2 great circles (true motion considered linear) on which the meteor appeared to move as seen from Danzig and Breslau, respectively, but not to suppose that single points, such as the beginning point or the end point, actually corresponded at both places. The latter assumption was the less admissible, since Mr. Kayser first saw the meteor, to be sure, at β Orionis, but does not designate this as the true beginning point, while, conversely, in Breslau, the point of the first bright flaring up was apparently more certainly determined than that of the disappearance in the vicinity of the horizon, which was obscured by clouds. Ac-

cording to the method given by Bessel in Volume XVI of *Astronomical Notices*, I now proceeded by starting with 2 definite points of one apparent path (indeed, from the beginning and end points of the Breslau path), and sought the points corresponding to these on the other (Danzig) path; then, as is known, the point of intersection of the line Breslau-Danzig with the celestial sphere and 2 such corresponding points must lie on a great circle in the sky. In this manner, the points of the true path in space corresponding to the Breslau beginning and end points may be determined. The data employed were the following:

	α	δ
Breslau, beginning point,	131° 0′,	+45° 0′
Breslau, end point,	159° 0′,	+17° 0′
Danzig, beginning point,	77° 3′,	— 8° 22′
Danzig, end point,	99° 50′,	—16° 32′
Computed apex of the line, Breslau-Danzig,	209° 58′,	+35° 23′

Hence there result the following heights of the meteor above the Earth's surface:

at (Breslau) beginning point, 23 geographical miles,*
at (Breslau) end point, 2 geographical miles;

and the coördinates of the points on the Earth's surface above which the beginning and end occurred, expressed in terms of distances from the Breslau meridian and vertical, are:

	Meridian	Vertical
Beginning Point,	—26 mi.,	—13 mi.
End Point,	—48 mi.,	—23 mi.,

these distance being taken positive toward the west and south, respectively, and measured in geographical miles. However, the path so calculated is extended considerably too far to the east, since the Breslau end point is assumed too low in the drawing on the star chart. If one shortens the path so much backward that the more exact Danzig observation of the end point is satisfied, then one finds an end point which lies only about 4 miles to the right of the true place of fall.

Improved Calculation of the Path

After the true place of the fall had been established from direct observation, by the shower of stones, it was purposeless to carry out the astronomical calculation of the last paragraph in the same manner with more or less varying data. Instead, the peculiar position of the apparent path as observed at Breslau permitted a considerably simpler solution of the problem to be given in this case by means of plane triangles, since the motion of the meteor at Breslau was to be taken as exactly perpendicular to the horizon. Not merely does Mr. v. Sichart say so in his report, but another observer, also, states the following in the *Silesian Newspaper* of the next day, January 31: "When————passed the long bridge over the Oder yesterday evening at 6:45, the surroundings were very suddenly magically illuminated for 2 to 3 seconds. Involuntarily incited to look, he noted in the northeast (from his position) a shining meteor, which descended toward the Earth slowly and exactly vertically from a moderate height. It was of a pear-shaped form, with the bottom side the breadth of the full Moon; coming to a point at the top, it appeared dark red inside and more brightly colored at the

*[Galle takes one geographical mile as equal to approximately 22,854 Paris feet.]

sides. The entire splendid phenomenon lasted about 5 seconds." According to a third, probably less accurate, observation in front of the Gates of the Oder, outside the city, the meteor, dropping from a height of about 45°, moved at first a little from left to right and then perpendicularly, being extinguished at the end of its visible path as if swallowed up by a cloud.

Moreover, observers in the vicinity of Breslau described the motion of the meteor as a *drop*, and likewise those at Oels and in, and near, Liegnitz. One observer between Liegnitz and Lüben said: "The meteor seen only a little north of east fell from a height of about 15° to 20° in a precisely vertical line and burst at a small height above the hilly horizon. Descending slowly, it was like a small full Moon; it left behind a long, almost comet-like, reddish-yellow train; and, at bursting, it spread out a very bright red and greenish light. It lasted in all about 5 seconds."

If one can, accordingly, assume now that for Breslau the apparent path lay precisely on a vertical circle, then the true motion occurred above the straight line joining Breslau and Pultusk. Therefore, one can easily measure off the horizontal distances from this line of the beginning and end points observed at Danzig, since the azimuths of both points, as seen from Danzig, are known, being respectively 333° and 314°, measured from south around toward west.

These distances amount to 35 and 34 geographic miles. If one associates them with the observed heights of 23°8 and 8°2 and takes into consideration the curvature of the Earth, then the heights of the 2 points above the Earth's surface are 16.5 and 5.6 miles. Hence, one has a descent of 10.9 miles in a horizontal distance of 11.2 miles, from which an angle of inclination of the path to the horizon of 44° follows. Now the point of the first bright luminosity at Breslau was observed at a height of 38°4, and, since the distance, Breslau-Pultusk (=47 miles), is known, there follows thus, when the Earth's curvature is taken into consideration, 24 miles as the height of this beginning point above the Earth's surface. The difference between this result and that obtained from the purely astronomical calculation given earlier (which did not take into account the true point of fall) amounts, therefore, to only a mile. The total length of the oblique path from the 24-mile-high beginning point to the 5.6-mile-high end point at Pultusk amounts to *25 geographical miles*, the corresponding horizontal path being 18 miles. The latter commences between the cities of Leczyca and Lowicz, possibly at Piatek, and crosses the Vistula near Wyszogrod. Along this entire line the meteor must, accordingly, have passed very close to the zenith.

Comparison of this Computation with Other Observations; the Breslau Observation of the End Point

The next thing involved, therefore, is to compare the remaining observations at hand with these results, secured from the calculations based on the Breslau and Danzig observations, and thus to secure certain desired tests. In this respect it is to be added, first of all, in regard to the Breslau observation of the end point, that, as a matter of fact, the drawing on the star chart used previously, in the first calculation, does not agree with the true end point but that the written report of a disappearance "at a height of 4° to 5° above the horizon" actually agrees very well with the Danzig data. At a distance of 47 miles (3° 8′ in arc) there follows, from the apparent height of 4°5, an elevation of 5.0 miles above the Earth's surface, while the Danzig observation leads to 5.6 miles. However, Mr. v. Sichart's written statement of a height of 4° to 5° is to be preferred to

the drawing, because the latter is made with reference to the horizon on a star chart which does not correspond perfectly to the sidereal time of the phenomenon.

LEOBSCHÜTZ; RATIBOR; TROPPAU

At Leobschütz, as Professor Fiedler writes, the meteor was observed by Master Mason Pietsch, who, while returning to Schlitter from Troppau, had directed his gaze to the constellation of Ursa Major when on a hill near Bladen and, at that instant, saw a fireball come from the star β Ursae Majoris and move toward the northeast (therefore to the right); the fiery phenomenon grew larger, the closer it came to the horizon, and lasted 2 to 3 seconds. A second observation from the region near Ratibor was submitted by Mr. Edward Kern, the owner of an estate, who was half a mile east of Ratibor on the highway leading to Rybnik. "Looking toward the constellation of Ursa Major, he saw the meteor somehow originate. From between the 2 middlemost stars in the tongue of the Wagon, a star, which he at first glance supposed a shooting star, detached itself. In falling, however, it became larger and changed its appearance. It became more intense and magnificently blue. Immediately afterwards, the red train, which grew ever redder, became visible; at its earthward end, a dark pear-shaped mass was recognizable. When it disappeared behind the trees of the forest, a very intense red glare suddenly flashed up. The meteor fell in an eastern direction and lasted about 8 seconds." Finally, the *Austrian Journal for Meteorology*, III, p. 121, contains the following report from Troppau: "The observer at first believed that he was observing a shooting star of very small size moving slowly in an eastern direction in the constellation of Ursa Major, but its light had a strikingly white luster. The motion of the luminous body increased with uncommon rapidity, and at the same time it grew larger, so that, while even at a great distance from the horizon, the body, which now emitted an altered light, intensely red-hot in the middle and greenish-yellow at the edges, had almost the apparent diameter of the Sun. The interesting thing was the train of the meteor, which showed over its whole extent the most intense carmen-red color without any variation. The fiery trace of the path traversed was perceptible up to the constellation of Ursa Major. From the moment of appearance, until the meteor disappeared, after descending in the eastern sky, the phenomenon lasted about 10 or 12 seconds." All 3 observers from this southernmost part of Silesia accordingly agree that they first noticed the meteor in the constellation of Ursa Major, in which the apparent path actually would fall, according to the preceding calculation. In order to make possible a somewhat more exact comparison with the observations at Leobschütz and Ratibor, it should be understood that at Leobschütz we must have:

Azimuth of beginning,	207°
Azimuth of end,	220°
Height of beginning,	34 mi.
Height of end,	6 mi.,

and at Ratibor:

Azimuth of beginning,	200°
Azimuth of end,	214°
Height of beginning,	36 mi.
Height of end,	6 mi.

Therefore, at Leobschütz, the meteor must have commenced 2° to the left of α Ursae Majoris and moved toward the northeast, between β and γ, obliquely but rather steeply. At Ratibor, it must have commenced between κ and λ Draconis

and then similarly passed between δ and ε Ursae Majoris, *i.e.*, between the Wagon and its tongue (or, as one can say, between the centralmost stars of the whole Wagon), inclined toward the right. Hence it becomes evident that the deviations from the statements of the 2 observers given previously can be regarded as rather small; if one wanted to hold more exactly to the wording of the statements, then, at Leobschütz, the beginning would be placed some degrees too far to the right and, at Ratibor, a few degrees too far to the left. The mean of both determinations leads to a path agreeing completely with the calculation and may accordingly be regarded as an important confirmation of it.

Ragendorf in Hungary; the Point of First Appearance of the Meteor Still Higher than 24 Miles; Height of the Atmosphere

A more exact statement of the course of the meteor through the constellations is available also from Ragendorf in Hungary, on which Dr. Schuh reports as follows in the *Austrian Journal for Meteorology*, III, p. 123: "When on the evening of [January] the thirtieth, I was driving from Somerein to Ragendorf (in a south-north line) in bright moonlight, I saw a shooting star in the direction of Ragendorf. It appeared in Ursa Minor below the Pole Star and moved in a northeast direction through the constellation of Draco and between the stars ε and ζ of Ursa Major toward the horizon. By the time it reached the region of Ursa Major, it already appeared as an unusually bright luminous meteor; still lower, spark-showering rays appeared. As it disappeared on the horizon, it illuminated the surroundings (but to no great height) as if with a red stage-fire. The entire duration of the phenomenon amounted to 4 to 5 seconds; the final illumination, to one second. The fireball became ever more luminous and larger as it approached the horizon; the train developed a light like that of an intense petroleum flame, with a rainbow-like, hazy glow. Incidentally, very close to the horizon, the ball was 2 to 3 times as large as Venus." This observation adds an essentially new result to the previous ones, insofar as, according to it, the first flaring up occurred at a height considerably greater than the 24 miles calculated previously, which latter height appears to indicate only the beginning of a brighter stage in the phenomenon. If one calculates, on the basis of the Breslau-Danzig path, the azimuth and height of this point as seen from Ragendorf (*i.e.*, from 34° 50′ [east] longitude and 48° 0′ north latitude), there result:

Azimuth, 199°; Height, 18°,

at a distance of 4° 20′ = 65 geographical miles. This point must have appeared, accordingly, near ζ Ursae Majoris, and, of this position, Dr. Schuh says explicitly that here the shooting star increased to an "unusually bright luminous meteor." In fact, it is not to be expected that attention would have been directed to the shooting star as early by an observer situated in Breslau, in view of the bright gas illumination in the city, as by an observer in the open country on a road running due north. Hence, if one calculates the end point near Pultusk as seen from Ragendorf, which must appear at azimuth 207° and height 4°, and prolongs the line joining the 2 points farther upward, one finds, then, in complete correspondence with the statements of Dr. Schuh, that the shooting star moved from Ursa Minor through Draco before it arrived at the position between ζ and ε Ursae Majoris. One will accordingly be able to assume that it flared up no later than in the neighborhood of the star α Draconis, standing obliquely below the Pole Star, *i.e.*, at a height of about 30°, and at a *real* height of 35-40 miles above the Earth's

surface over territory lying near the Polish border, not far from Kalisch.

By the previously emphasized agreement of the observations of Dr. Schuh with the results at Danzig and Breslau, as concerns the point of brighter flaring up, one accordingly reaches the very definite result—already inferred also from very many other observations of meteors—that the height of the Earth's atmosphere is to be regarded as considerably exceeding the limit of 10 miles usually given and deduced from observations of [the duration of] twilight. One is thus immediately in agreement with the observations of Liais, in 1858, in the tropics (Brazil), according to which the atmosphere still showed a polarization from directly incident sunlight long after the disappearance of twilight, which fact likewise gave its height as exceeding 4 to 5 times the ordinary assumption (*C. R.*, XLVIII, 109). In resisting planetary velocities of several miles a second, the air accordingly shows itself still capable, even in this most extreme degree of rarity, of effecting an immediate combustion of meteoritic bodies entering the atmosphere.

KROTOSCHIN

From Krotoschin, in the Grand Duchy of Posen, Mr. Theodore Laser reports that he saw the meteor in the open country on the highway leading to Ostrowo, ⅛ of a mile from Krotoschin. "The meteor was perceived at a height of about 70° as a point the size of a star, which enlarged as it fell and increased in luminosity; the meteoric light itself had a characteristic phosphorescent radiance very similar to that of a Bengal light. The meteor was seen approximately toward the northeast. The meteor was brightest at a height of 45°, and the luminous body was then as large as a hulled coconut. With farther descent, the body decreased in luminosity until, at last, it was not unlike a glowing ball. When the meteor had descended to within about 15° of the Earth's surface, glowing pieces broke off and fell to the ground, along with the main undisintegrated mass." In a later letter, Mr. Laser reports also, in regard to the height of the beginning point, that in comparison with the height of 51° of the Pole Star, it could have amounted at most to 60°. According to the preceding computation of the path, the beginning *should* have been observed at a height of 52°, but it is, of course, entirely possible that at Krotoschin (which lay closer to the meteor than Breslau), the beginning was noticed sooner and perhaps at an altitude as great as even 60°. If one assumes the calculated path to be correct, the latter value of 60° would give a height of 27 miles at a horizontal distance of 16 miles. However, because of the great apparent height of the beginning point above the horizon, it is conceivable that the shooting star was actually first seen later here and at other places located near its beginning than, *e.g.*, in distant Hungary. As is well known, in observations near the zenith uncertainty with regard to directions in the sky easily occurs. In the present case, the point of appearance, shown in the north-northwest on a drawing added to Mr. Laser's letter, is but little in agreement with the computation; such a direction would place the beginning in the region of Posen, which would oppose the direction statements from Warsaw and from Pultusk itself as well as from Breslau and other places. As concerns the height of the end point (15°), this result is to be considerably diminished (since, according to known experiments, heights near the horizon are estimated too large). The description of the bursting of the Pultusk meteor corresponds completely to other observations made of this meteor and of other fireballs. Some discussion of different possible interpretations of this feature will be given later.

[*To be continued*]

Two Outstanding Texas Meteors of the 1942 Summer

In the August, 1942, issue of POPULAR ASTRONOMY, Mr. George B. Hufford of Austin, Texas, reported a very bright meteor on 1942, June 17; the correct time was 10:24 P.M., C.W.T. A copy of his original observation gave us valuable data, especially as to the beginning point. The writer had the good fortune of seeing this same meteor from Ft. Worth, and the apparent path from there was immediately measured and recorded. A preliminary mail-survey was supplemented by a field-survey; Paul Atchison of Abilene, Wm. Monnig III of Ft. Worth, and the writer traveled in a rough circle with a diameter of 60 miles around the final part of the meteor's path. The following preliminary facts have been ascertained:

The meteor became luminous over eastern Runnels County, Texas, between Ballinger and Coleman, at a height of about 80 miles. Traveling in an azimuth about N. 15° E. and dropping at a slope of about 45°, it ended over the northwestern part of Shakelford County just south of the Clear Fork of the Brazos River at a height of about 11 miles. Some of the nearer observations indicate the end height may have been as low as 7 miles. The meteor passed nearly over Abilene and was detonating there and for 30 miles to the east and to the west as well as on up to the sub-final region. The projected path length is about 70 miles. The duration of flight was very close to 7 seconds.

Near its end the zenithal magnitude seems to have been about —11. The meteor was remarkable for a lack of disintegration; it simply "went out" at its visible end. Just beyond sub-final point we located a witness who saw the general illumination, heard the shock wave, and then heard the sound of the meteorite going by, like an airplane coasting. Only 4.6 miles slightly east of north from this witness we found another who saw the expiring meteor as a red ball at an altitude of about 47°; he was beyond the zone of the shock wave and heard no sound whatever. It seems certain that there is a meteorite (or several) in the territory between these two. We have urged local inhabitants to search and H. H. Morse and the writer searched personally for one day, but to date nothing has been recovered. The region is grass-covered ranching land including Bluff Creek (generally dry) and a few draws leading into it, and the chances of ultimate recovery seem reasonably favorable.

A second spectacular meteor, not so bright, but even more widely seen because of a record-breaking path length and duration of flight, appeared 1942, Aug. 7, 9:30 P.M., C.W.T. It began over northeast Texas (possibly even over Louisiana), and in a flight lasting fully 30 seconds, perhaps 35, moved diagonally across most of the state of Oklahoma to its northwestern Panhandle county of Cimarron, and perhaps even on over Baca County, Colorado. We have not been able to make a field survey of this remarkable object, and probably will not be able to do so because of war conditions. Hence we appeal to any amateur who observed this meteor for a carefully *measured* path observation.

This meteor had a real path length easily 500 miles long, and perhaps nearer 600 miles. The beginning height was probably in excess of 80 miles; we have no evidence for an end height below 20 or 30 miles. The meteor was not the red, "dying ember" type, but was generally reported as colorless or yellow. It left a very brief-enduring train. We have some doubts whether the zenithal magnitude ever exceeded —8, and probably it was not over —6 in the earlier part of the path. No definite reports of any detonations have come in, and the criteria gen-

erally depended upon to indicate the fall of a meteorite are negative. Nevertheless, there may certainly be exceptions to such rules, and the meteor is worthy of the fullest investigation for many reasons. We are particularly anxious for a report from any one just beyond the endpoint (in southeastern Colorado), or from any one who may have seen the earliest portion of the path, say from Arkansas or Louisiana. We already have reports stretching all the way across the northern portion of Texas (exclusive of the Panhandle, where it was party cloudy) and from scattered Oklahoma and Kansas points.

OSCAR E. MONNIG.

1010 Morningside Drive, Fort Worth, Texas,
1942, September 14.

A Bright Bolide Observed

A bolide at least as bright as the full moon passed from north to south over the state of New Jersey at 11:30 P.M., E.W.T., September 1, 1942. Many observations have come in from those living in the Philadelphia area, but none as yet from observers who may have seen the object in the western sky. Reports may be sent either to the Fels Planetarium, Philadelphia, Pennsylvania, or to Flower Observatory, Upper Darby, Pennsylvania.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Twenty Provocative Stars: At a recent gathering of astronomers the question was raised as to the most provocative and interesting stars to be found in the sky. The list naturally started with the sun as of prime importance, and gradually grew to twenty. These are listed herewith, not necessarily in order of importance.

Sun	α_2 Canum Venaticorum	Barnard's Star
Algol	Castor	RS Ophiuchi
SS Cygni	η Carinae	RW Tauri
o Ceti	Polaris	ζ Aurigae
Sirius B	Nova Herculis	β Lyrae
SN 1054	R Scuti	CY Aquarii
DF Cygni		R Coronae Borealis

The sun, as our nearest star and giver of life to terrestrial creatures, needs no testimony as to its prime importance. Its corona has long been, and will long continue to be, a most provocative phenomenon. Perhaps, with the advance of the coronagraph, we may ere long answer some of the provoking questions concerning not only the corona, but the prominences as well.

Algol, β Persei, the first of the eclipsing stars to be discovered, still presents its problems, even after nearly two centuries of study. And, too, it is considered as one of the typical eclipsing variables, with many relatives. Its period-change behavior still requires further study.

SS Cygni, a star which, in spite of nearly fifty years of intensive study, still defies interpretation, is of the greatest interest. It appears to combine most of the regular and irregular features displayed by other individual stars of this mildly explosive type of variable. Although not the first of its class to be found,

it has, because of its greater brilliance, become the best and most frequently observed.

Omicron Ceti, Mira was the first variable to be detected and, in spite of its more than three centuries of observations, is still of exceeding interest, and is considered the prototype of most Me long-period variables. Its large variation in light at maximum, and in times of increase to maximum, still needs considerable study. Also the presence of a companion makes it additionally important. Its spectrum has been the most thoroughly studied of all long-period stars.

Sirius B, the companion of Sirius A, because of its great density, especially when compared to Sirius A, is most provocative. Why it should be associated with Sirius A, of nearly the same mass and color, but of such different size, density, and constitution is a mystery.

SN 1054, the supernova at the center of the Crab Nebula, is of intense interest, especially in view of the fact that it has been suggested that the Crab Nebula itself may be the product of the supernova outburst.

α_2 Canum Venaticorum, also known as Cor Caroli, has been a puzzling star for a long time, mainly because of the fact that its spectral absorption lines showed very unusual changes in intensity and appeared to be unique in this respect. Now, however, several other A-type stars are known to behave similarly. A certain set of lines in Cor Caroli, known as group A lines, appears to vary in intensity in a regular period of five and a half days. Group B lines vary in the opposite sense to the group A lines. The star is also included among those which are known to vary in light. Cor Caroli is truly a mystery among the stars!

Castor, α Geminorum, a remarkable multiple-star, has been under observation for more than a century, and was the particular "pet" star of Sir William Herschel. Today it is of continual interest, especially to double star observers. Two of its components constitute the eclipsing variable, YY Geminorum.

Eta Carinae, one of the most spectacular of the nova-like stars, has a bright line spectrum that gives one cause for deep contemplation. With many of the attributes of a nova, it still presents plenty of enigmas, and is probably unique in its behavior among stars of its kind.

Polaris, with its complicated motions, besides being of prime interest as the pole-star, is a Cepheid variable of the shorter period class—4 days—with a very small amplitude of variation, less than two-tenths of a magnitude. In other words, its reputation for constancy is ill-deserved.

Nova Herculis, now after nearly eight years of study, remains one of the best representative novae. The similarity in form of its light curve to that of T Aurigae, nova of 1891, is remarkable. Still more remarkable is the fact that there is now an elliptical nebula surrounding the star, with the (NII) lines concentrated in nebulous knots.

R Scuti, perhaps one of the best examples of the RV Tauri-type, remains, in spite of the many years over which it has been observed and studied, a partially unsolved star.

Barnard's Runaway Star has the largest known proper motion of any star. It is situated in Ophiuchus and has an annual proper motion of more than ten seconds. It is only six light years distant, with an absolute magnitude of 13.4.

RS Ophiuchi, probably the best example of a recurring nova, is typical of this class. With already two well-observed outbursts to its credit at an interval of thirty-five years, one wonders if, and when, another explosion will take place.

RW Tauri, a totally eclipsing variable with one of the greatest amplitudes—3.4 magnitudes—presents remarkable spectral changes that can best be interpreted as resulting from the eclipse of a bright gaseous ring around a small blue primary component—in other words, the existence of a Saturn-like star.

Zeta Aurigae is one of the long-period eclipsing variables whose amplitude varies from 0.1 to 2.1 magnitudes, depending on the wave-length of the light in which the star is observed. It is one of those variables which best provides us with the means of studying the atmospheres of the stars, and is noted for the great disparity of the two components.

Beta Lyrae presents one of the most complicated of spectral conditions to be found in eclipsing variables. Although considerable progress has been made in recent years in the interpretation of these spectral changes and their bearing on the problem of what is taking place in the star, there is still more to be learned as regards the system as a whole.

CY Aquarii is of particular interest mainly because of its exceedingly short period for a Cepheid, approximately 88 minutes; in fact it has the shortest period known for any variable. A change of half a magnitude can be noted within a quarter of an hour when the star is increasing in brightness.

DF Cygni, perhaps best classed as another RV Tauri star, has many peculiarities to be found in few other stars. Two periods are apparently present, one of 50 days and another of 782 days, with greatly varying heights of maxima and minima for the short term variation over the long term period.

R Coronae Borealis, though long on the list of variable star observers the world over, still remains an entertaining star. Being the prototype of a class, and the brightest of them all, its caprices are being watched by hundreds of eyes. Sometimes the star remains at or near maximum for ten years, at other times the drop to minimum occurs after a lapse of only a year or so after maximum light has been attained. Some good theories have been propounded to account for these sudden and deep drops, but more needs to be learned concerning the causes and meanings of variation in the R Coronae Borealis class, all of which may be considered as carbon stars.

Another group of astronomers doubtless would have compiled a list somewhat different from the one here presented. That seventy per cent of the stars in this list are variables may be partly due to the fact that most of those who suggested objects to be included are mainly variable star workers of one sort or another.

RY Sagittarii: The R Coronae Borealis-type variable RY Sagittarii is, according to a report from Mr. Joseph Meek, and confirmed by Messrs. Holt, Jones, and Rosebrugh, definitely on the decrease to a minimum. Usually about magnitude 6.5, the star had, on September 5, reached magnitude 8.4.

The last preceding decrease in light of this variable occurred in October, 1938, when the star reached magnitude 11.6 at the end of that month. Nearly a year was required for the star to regain its normal maximum brightness, with many remarkable fluctuations in light during this interval. (See these notes for December, 1939, for light curves.)

SU Tauri, another star of this same class, is still at one of its faint stages. S Apodis appears to be at maximum brightness with no marked indication of a decrease in light since the minimum of 1934-35, an interval of seven years. (See these notes for November, 1938, for light curves of four of the R Coronae Borealis-type stars for 1930-38.)

Visual Observations of Comets: Professor N. T. Bobrovnikoff, director of the Perkins Observatory at Delaware, Ohio, has shown very clearly in his recent statistical studies of the brightness of comets, that ordinary magnitude estimates of these objects have a very definite value and importance in our knowledge of comets. Such observations, whether telescopic or naked-eye, will aid greatly in the study of future comets, and Dr. Bobrovnikoff earnestly desires that such observations be made.

It would seem that variable star observers, especially the amateur, could do very valuable work along this line, and those who are desirous of taking part in this important program are urged to communicate directly with Dr. Bobrovnikoff, who will be pleased to supply the necessary information and assistance.

A. A. V. S. O. Meeting: The 31st Annual Meeting of the American Association of Variable Star Observers will be held, as is customary, at the Harvard Observatory in Cambridge, Massachusetts, on October 9 and 10. Although traveling conditions do not improve with the continuation of the war, it is hoped that those members who do not reside at too great distances may be able to attend. We cannot expect to have the attendance which has prevailed in previous years, but despite the difficulties an interesting program is being arranged.

Observers and Observations: Thirty-six observers contributed observations to a total of 2596 during July, an average of 72 observations on 41 stars per observer. For August the values stand at 50 observers, 2988 observations, or an average of 60 observations on 40 stars for each observer. We welcome back to the ranks of active observers after months of inactivity Messrs. Albrecht, Carpenter, Heckencamp, Herbig, Hiett, Meek, Moore, and Palo.

New contributors include Messrs. Duffie, of Montreal, Canada; Hale, of Tustin, California; Konig, of the Milwaukee Astronomical Society; and Segers, of Buenos Aires, Argentina.

Fortunately observations continue to come in from distant points such as those from Chandra of India; Cousins, Houghton, and de Kock of South Africa; and Mrs. Dafter and Howarth of Australia.

Observations received during July and August, 1942:

Name	July Var.	July Obs.	August Var.	August Obs.	Name	July Var.	July Obs.	August Var.	August Obs.
Albrecht	..	..	5	6	Harris	21	21	14	14
Ball, A. R.	..	..	30	51	Hartmann	82	84	103	119
Blunck	28	38	31	42	Heckencamp	..	..	2	6
Bouton	44	48	41	54	Herbig	..	..	91	102
Buckstaff	7	10	14	31	Hiett	..	..	15	21
Carpenter	..	..	5	5	Holt	45	48	76	85
Chandra	170	396	135	179	Houghton	..	..	30	30
Cilley	47	98	79	203	Howarth	16	22	15	21
Cousins	62	147	44	97	Huffer	19	19	18	18
Dafter	8	65	..	..	Jones	46	131	70	151
Diedrich	..	..	13	17	Kearons	52	88	66	117
Duffie	7	7	21	32	Kelly	12	16	10	12
Fernald	196	337	203	494	de Kock	66	193	57	164
Ford	34	37	..	..	Konig	..	..	7	7
Garneau	10	12	25	35	Koons	72	88	76	132
Giese	..	..	6	7	Lovinus	..	..	7	11
Griffin	15	15	15	15	Manlin	67	70	69	69
Halbach	..	..	50	67	Mason	3	3	..	..
Hale	..	..	2	3	Maupomé	..	..	26	28

Name	July Var.	July Obs.	August Var.	August Obs.	Name	July Var.	July Obs.	August Var.	August Obs.
Meek	..	..	20	30	Schoenke	..	..	50	98
Moore	..	..	7	7	Segers	13	64	11	32
Nadeau	10	10	39	54	Sill	..	..	73	73
Palo	12	15	..	..	Stahr	17	17	16	19
Parker	52	52	..	..	Topham	21	21	..	..
Parks	27	54	70	105	Toyek	..	..	1	1
Peltier	164	233	77	125	Vohman	15	18	30	39
Reeves	..	..	2	3	Webb	14	17	10	10
Rosebrugh	8	19	6	12	Weber	81	90	85	85

Total observers: July 36, August 50.

Total observations: July 2596, August 2988.

September 15, 1942.

Comet Notes

By G. VAN BIESBROECK

There are no known comets visible at this time except the very faint PERIODIC COMET FORBES 1929 II. Few observations of the latter have been obtained on account of unfavorable sky conditions during the dark of the moon, and since the theoretical brightness is diminishing it will remain a very difficult object.

PERIODIC COMET GRIGG-SKJELLERUP has faded very rapidly in July and could no longer be located here in August.

The search for the expected PERIODIC COMETS WOLF No. 1 and SCHWASSMANN-WACHMANN 1 has not been successful so far.

One more periodic comet, REINMUTH 1928 I, may be recovered before long. It does not come to perihelion until December 5, 1942, according to the prediction by M. Sumner (*Handbook of the British Astr. Assn.* 1942) and the geometric conditions are such that the most favorable time of observations is in the early months of next year. However the comet may already be in reach before long as a morning object, as shown by Sumner's ephemeris based on the elements computed from the first return in 1935. The period is a little over seven years.

EPHEMERIS OF COMET 1928 I

1942	α h m	δ ° ′	Distance from Sun	Distance from Earth
Sept. 4	7 56.8	+17 57	2.15	2.78
12	8 14.8	17 19	2.13	2.69
20	8 32.7	16 34	2.11	2.61
28	8 50.4	15 44	2.09	2.53
Oct. 6	9 7.9	14 51	2.08	2.44
14	9 25.2	13 54	2.06	2.35
22	9 42.2	12 55	2.05	2.27
30	9 58.8	11 55	2.04	2.18
Nov. 7	10 15.0	+10 54	2.03	2.10

Williams Bay, Wisconsin, August 28, 1942.

ADDENDUM TO THE COMET NOTES

No ephemeris being available for the present opposition of the variable PERIODIC COMET SCHWASSMANN-WACHMANN No. 1, I have computed an orbit

from three Yerkes Observations in 1941 neglecting perturbations. The resulting ephemeris is as follows:

1942	α h m	δ ° ′	Distance from Sun	Distance from Earth
Sept. 30	23 40.1	+ 5 30	5.68	4.70
Oct. 8	36.8	5 11	.69	.73
16	33.8	4 53	.69	.78
24	31.2	36	.70	.85
Nov. 1	29.3	22	.71	4.94
9	27.9	10	.71	5.04
17	27.3	4 02	.72	.15
25	27.4	3 58	.72	.27
Dec. 3	28.2	3 58	.73	.40
11	29.7	4 02	.73	.54
19	31.8	11	.74	.67
27	23 34.6	+ 4 24	5.74	5.80

On September 6 the comet was observed with the 82-inch reflector of the McDonald Observatory. It showed a sharp nucleus surrounded by a round coma 2′ in diameter. The total magnitude was estimated as 12. The correction of the above ephemeris was $+1^m3$ and $+10'$ for the date September 6 and will increase only slowly for the balance of the year. It will be of interest to follow the changes in brightness which from the previous history of this object are almost certainly going to take place.

Fort Davis, Texas, September 8, 1942.

General Notes

Mr. Charles E. Rogers, for many years a teacher of Astronomy in Trinity College, Hartford, Connecticut, a member of and a frequent attendant at the meetings of the American Astronomical Society, and a subscriber for many years to POPULAR ASTRONOMY, died at his home in West Hartford, Connecticut, on June 30.

Dr. Joseph Haines Moore has been appointed director of Lick Observatory, University of California. He became a member of the staff of the observatory in 1903, and since 1936 has been assistant director. He succeeds Dr. William H. Wright, who, having reached the age of sixty-five years, retired on July 1. Dr. Wright retains the rank of astronomer and expects to continue his work at the observatory. (*Science,* July 17, 1942.)

Astronomical Activity in New Zealand

With the war raging at their very door, it would seem that the thoughts of the people of New Zealand would be completely occupied by it. Judging by the copy of *Southern Stars,* the Journal of the New Zealand Astronomical Society, recently received, the interest there in astronomy seems undiminished.

The copy before us contains a two-page editorial in answer to the question, "Shall we carry on?". The conclusion is a ringing affirmative. The argument is the familiar, although sometimes the forgotten one, that even when the future looks dark and foreboding, astronomical work and contemplation reveal the eternal fact of the transitoriness of mundane events in the sweep of cosmic forces and laws.

An Historical Landmark

The accompanying cut is of a photograph sent by Mr. Charles Skeele Palmer some years ago. This site, having played such an important role in the development of astronomical apparatus in this country, it is deemed worthy of being preserved in this manner. Mr. Palmer's comments concerning it follow. Ed.

"I am enclosing herewith a small photograph of the old stand used by the Alvan Clarks of Cambridge, Massachusetts, in all the testing of their large ob-

Mounting for Testing Telescopes

jectives. Alvan Clark, Sr., once told me that it would carry a 50-inch glass, though that size had never been ordered.

"The photograph was taken by my friend, Dr. George Karns, a local fellow-chemist, who is quite an enthusiastic student of astronomy, having made for himself a 6-inch reflector, silvered glass, of good worth and definition. When he took the photograph, plans were being made, September, 1928, for the destruction of the old plant, and this is probably one of the last taken of that memorable and historic place of the making of large objectives."

January 2, 1930.

Barnard Observatory.—The astronomical observatory of Vanderbilt University, founded over sixty years ago, will hereafter be known officially as "Barnard Observatory of Vanderbilt University" in honor of the late Edward Emerson Barnard, the distinguished astronomer who was an alumnus of the university.

Rittenhouse Astronomical Society.—An extra meeting of the Rittenhouse Astronomical Society was held on Friday, September 25, 1942, in the Lecture Hall of the Franklin Institute. Dr. Dean B. McLaughlin, professor of Astronomy, University of Michigan, secretary, American Astronomical Society, gave an address on the subject "Temporary Stars," at this meeting.

Monthly Astronomical News Letter

A copy of the first edition of the publication described in the title has recently been received at the office of Popular Astronomy. The purpose it is intended to serve is stated in an introductory paragraph as follows:

"The war has disrupted the world-wide exchange of information on progress

in all fields of science. Research does continue, however, and to keep you informed of work being done today in the United States this communication has been prepared by the American Astronomical Society under the direction of Bart J. Bok of the Harvard Observatory at Cambridge, Mass. It is distributed by the Department of State of the United States Government and more copies can be secured at any Legation or Embassy of the United States."

Number 1 consists of four mimeographed pages and includes summaries of important papers recently presented in the United States, personal notes, and a review of recent studies on comets and their spectra.

As the name suggests, a similar letter is to be issued each month.

Observatories in Great Britain

The heroism and determination of the English people under existing circumstances are dramatically represented in the continuity of the sending out of the "six pips" from the Royal Observatory at Greenwich, furnishing exact time to people at home and to the numerous ships at sea. The copy of *Monthly Notices* recently received shows that other work, as well as the time service, is being carried on without serious interruption at Greenwich. Moreover, there are seventeen other observatories, some of them belonging to private individuals, in the British Isles, and eleven scattered throughout the Empire whose activities are summarized in the copy mentioned above.

It is a heartening fact that the eternal stars, symbol of permanency, are not lost sight of in the daily turmoil and anxiety. This thought was forcibly expressed by Mr. Churchill, speaking before the American Congress on December 26, 1941, when he said, "I would say that a man must indeed have a blind soul who could not see that some great purpose and design is being worked out on earth, for which we have the honour to be the faithful servants. It is not given to us to peer into the mysteries of the fuure."

The Observer. Copies of two issues of the publication by the above name have recently been received, one for July and one for August, 1942. The former, in addition to local items of interest to the Yakima Amateur Astronomers, whose official publication it is, contains a photograph and a sketch of the moon, the sketch indicating the names of numerous features. This is very useful for identifying lunar markings. The second as a special feature contains a list of the 26 largest reflecting telescopes in the world and a list of 18 of the largest refractors. These lists are of interest to all workers in astronomy. The Yakima Amateur Astronomers are to be complimented upon the continued activities in their organization.

Meteorologists Wanted

Requirements for meteorologist positions in the Federal Government have been modified in an effort to secure additional qualified persons for civilian war work, both in the United States and abroad. Appointments are to be made at Army and Navy air bases, and at Weather Bureau Stations.

Appointees will work with specific problems in the field of meteorology, most of the problems being connected with some phase of the war program.

Completion of a 4-year course in meteorology or closely allied subject at a recognized college, with a minimum of 2 years of professional meteorological

experience, is required. Under the new announcement issued by the Commission, college teaching in meteorology is accepted as professional experience, provided that all other requirements for the position are met and that the teaching was carried on with the minimum rank of instructor. There are no age limits. No written test will be given, applicant's qualifications being judged from their record of accomplishments, experience, and education.

Applications must be filed with the Washington office of the Civil Service Commission, and will be accepted until the needs of the service have been met. Persons who received eligible ratings under previous meteorological examinations need not apply again.

Junior Physicists and Technical Assistants Needed for Civilian War Service

War with its emphasis on production has over night changed the theoretical problems of men engaged in technical and scientific work into problems of practical importance—problems demanding immediate answers. To aid them in meeting these demands, professional men are calling for hundred of Technical Assistants as well as Junior Physicists.

In view of the scarcity of qualified persons to fill such positions, the Civil Service Commission has issued in revised form, its continuously open examinations for Technical Assistants and Junior Physicists.

For Junior Physicist ($2,000) the requirements are: Completion of a 4-year college course including 18 semester hours in physics. Applications will be accepted from senior students who expect to complete the required courses within 6 months after filing applications.

The Technical Assistant ($1440-$1800) examination contains 3 optional branches: Engineering, Metallurgy, and Physics. For the $1,800 grade, three years of college study is required; for the $1,600 grade, two years; and for the $1,440 grade, one year. To qualify under any one of the options in any grade, certain requirements as to hours of study in specified subjects must be met.

Provision is made for the acceptance of Technical Assistant applications from persons who have not completed the required 3, 2, or 1 year of college study but who expect to complete the required courses within 4 months after filing applications. Appropriate War Training Courses may be substituted for college hours required in any optional branch.

There are no age limits for these examinations. No written tests are required. Applications will be accepted until the needs of the service have been met. Applications are not desired from persons engaged on War work unless a change of position would result in the utilization of higher skills possessed by the worker.

Announcements and application forms may be obtained at any first- or second-class post office or from the Civil Service Commission, Washington, D. C.

Issued, September 1, 1942.

Book Reviews

Principles of Stellar Dynamics, by S. Chandrasekhar. (University of Chicago Press, Chicago, Illinois. $5.00.)

During the last few years there have appeared in the astronomical literature a large number of papers discussing the motions of stars in large systems. These papers, many of which have been written by Dr. Chandrasekhar, have dealt with such subjects as galactic rotation, average stellar motions, the existence of spiral arms in external galaxies, and the development of globular clusters. With the appearance of this book, one of a series of Astrophysical Monographs sponsored by the *Astrophysical Journal,* much of this material is gathered together in a unified whole, and put into what the mathematician and theoretical astronomer will find a more readable and usable form. The astronomical amateur will probably not be interested in such a highly mathematical text, with more than 300 equations in the first 100 pages, and many more in the remaining 151 pages; but to a specialist in the field this brilliant work should prove invaluable.

The first chapter deals with some of the basic principles of the subject of stellar motions. The meaning of some of the mathematical concepts usually employed is examined in detail. The relationship of galactic rotation to the observed radial velocities of stars, and to the asymmetry of high velocity stars is also discussed. An excellent summary of the classification of the external galaxies is included, well illustrated with photographs of these objects.

The second chapter deals with what is called, "The Time of Relaxation of a Stellar System." This is essentially the time required for an individual star to lose all traces of its original energy by encounters with others stars. This is a subject where rough approximate formulae have been known for some time. The original work by Dr. Chandrasekhar in this field has eliminated many of the uncertainties inherent in former analyses, and has yielded formulae which are based on fewer approximations than the previous ones. The results obtained in this chapter show that chance encounters between stars are negligible in galactic systems, but may be important in globular and galactic clusters.

The following two chapters on "Galactic Dynamics" and "General Dynamics of Stellar Systems," both consider motions of stars when interactions between individual stars may be neglected. The only force governing each star in a galaxy is the gravitational attraction of the galaxy as a whole, and each star keeps the same energy, kinetic plus potential, that it had a billion or so years ago.

It is physically surprising, perhaps, that so many results can be proved with the few assumptions that are made in these chapters. But the condition that a system is stationary, that roughly the same *number* of stars (though not identically the *same* stars) are doing the same things one year as the next, together with a reasonable restriction on stellar velocities, turns out to be surprisingly restrictive on the possible forms which a stellar system may assume. This analysis, which is a condensation of several lengthy papers in the *Astrophysical Journal,* retains a high degree of generality.

The discussion of spiral structure in the chapter on General Dynamics is not intended as a final explanation of this puzzling phenomenon, and is in fact too general to serve as more than a background for such an explanation. The implied

interpretation of spiral arms as regions of high star density *through* which stars pass, and not as paths *along* which they pass, is a useful shift of emphasis from previous work, and may prove to be an important part of the eventual final explanation of spiral structure.

Chapter V is devoted to the "Dynamics of Star Clusters." Star clusters are systems in which stellar encounters cannot be neglected, and in which stars interchange energy back and forth. This has the result that some stars accidentally acquire so much energy that the gravitational force of the cluster cannot hold them, and the stars leave the cluster, much as molecules "evaporate" from a liquid. Another fate which may befall a cluster, if it happens to be in a rotating galaxy, is to be torn to pieces by the forces associated with galactic rotation. Both these possibilities are extensively analyzed and the results of previous workers, together with Dr. Chandrasekhar's own contributions, are presented in an organized, systematic way.

The book as a whole, and the analyses which it presents, are noteworthy because of a continual attempt to preserve logical rigour as far as possible throughout, to minimize the number of assumptions made, and to indicate exactly where and why the few assumptions and approximations necessary are introduced. As a necessary result of this emphasis, the physical reasoning behind the equations is not always self-evident. But to those who are convinced that rigour, elegance, and generality are indispensable parts of a theoretical science, this book will serve as an ideal and an inspiration. LYMAN SPITZER, JR.

Manual for Observational and Practical Laboratory Work in Elementary Astronomy, by Oscar Lee Dustheimer. (Edwards Brothers, Inc., Ann Arbor, Michigan. $1.25.)

The third edition of this Manual appeared in January of this year. It consists of 100 pages, in lithographed form, outlining 112 exercises. Some exercises require only reading, others visual observations, still others simple instruments, and finally the micrometer, sextant, and telescope. There are numerous diagrams and charts throughout the volume. This edition contains separate star maps of the northern sky for each month of the year. The selection of material is good, and the organization of it also good. It will be found a very useful adjunct in the teaching of the elements of astronomy.

The Morning Star Rises, by Maud Worcester Makemson. (Yale University Press, New Haven, Connecticut. $5.00.)

The above title refers to a volume of 300 pages delineating the development of astronomy among the Polynesian peoples. In the foreword the author intimates that the account relates to incidents which transpired some 20 centuries ago. It is a source of great surprise to learn to what extent the starry skies entered into the thought of the people of those early centuries. On the other hand, it is only natural that the stars, the only guide available, should be used so elaborately by them in their extensive ocean journeys. Indicative of the detail to which star lore was developed, Chapter VII is devoted to a list of names of stars occurring in the Polynesian tradition. A total of 772 items are listed with their astronomical significance. A survey of this tabulation shows careful and accurate knowledge concerning the naked-eye stars. Other chapters relate to the mythological beliefs

of these early peoples relative to the origin of heaven and earth, cycles of the stars and moon, omens in the sky, etc.

A comprehensive map shows two journeys starting from New Guinea and terminating in Hawaii and New Zealand. Two other journeys are shown starting from the Society Islands and again terminating in Hawaii and New Zealand. It is not likely that the author and publisher realized in 1941, when this book was published, to what prominence this region would come in world events with a year.

"The Morning Star Rises" sounds ominously like "The Rising Sun." However, the primitive sea journeys of the early Polynesian peoples, although fraught with hardship and danger and requiring unlimited courage, nevertheless were peaceful in contrast with the martial and destructive sallies now occuring in these same waters. C.H.G.

The Stars in Myth and Fact, by Oral E. Scott. (The Caxton Printers, Ltd., Caldwell, Idaho. $3.00.)

This is an interestingly written volume of 365 pages setting forth the myths as well as the facts which through the centuries have become associated with the starry skies. Many charts, diagrams, and photographs are used in the presentation. The author's point of view and purpose in the book are expressed in the following paragraph taken from the printer's advertisement.

"The stars have fascinated the sight and mind of man since earliest times. Into their arrangement and courses he has read many meanings that have colored the religion and literature of all ages. This great body of legend and belief often deviates in its implications from astronomic truth, but in general the philosophic deductions are as metaphysically authentic today as they were in the ancient past. He who studies the stars does not appreciate them fully until he knows the truth and beauty with which man's imagination has endowed them. In the heavenly constellations man may not find the secret of his personal future as the astrologers claim, but he can learn basic philosophic facts which are as immutable as the cold, scientific findings of the mathematician." C.H.G.

Youth Considers the Heavens, by Elsa Marie Meder. (King's Crown Press, Columbia University, New York City. $1.00.)

This is the title of a pamphlet of 60 pages which presents the results of a study conducted with 364 students in high school physics classes. These young people expressed their opinions about man's place in the universe on a carefully prepared check list; then some of them studied specified astronomical material and some returned to their usual physics lessons. Later, all the students responded again to an opinion check list. Each person's two expressions of opinion were compared. They were studied as well with reference to "before and after" tests of information about the extent of the universe. It was found that, as such information increased, opinions shifted away from a conception of the supernatural domination of man.

There are good reasons for a study such as this: opinions about man's place in the world are important because they are expressions of beliefs, and beliefs direct people's actions. Furthermore, as a preliminary investigation confirmed, young people are concerned with the general problem of man's relation to the universe and consider seriously questions of a philosophical nature.

In a review, adverse, as well as favorable, comment is permissible. On page

42 the student is asked to pass judgment on the material used. The invitation to do so is given in this form, "Is there anything in this chapter that you do not think is explained well?". A severe critic would probably begin with this question.

Planisphere of Air Navigation Stars, by Francis Chichester. (George Allen and Unwin, Ltd., Ruskin House, London. 2s6d.)

This device for learning the names and location of the principal naked-eye stars consists of two charts capable of being rotated so as to suit the time of day and of the year. When the charts are properly oriented a mask fits over them disclosing only those stars visible at that moment. One chart is designed for use in 50° north latitude, the other in 35° south latitude. The application of it is fully and clearly explained on the back cover. It should be very helpful for one who is beginning the study of the sky.

Philips' Chart of the Stars, edited by E. O. Tancock. (George Philip & Son, Ltd., 32 Fleet St., London, E.C.4 3/-net.)

This chart is a large sized map of the sky. It is folded into a six by eight inches form for convenience. When unfolded to its full extent it discloses the sky through the twenty-four hours from sixty degrees north declination to sixty degrees south. The north and south polar regions are given as separate insets. The background of the sky is light blue, and the stars are shown as white dots thereon, the size of the dot indicating the brightness of the star. Various tables and explanatory notes are included. It can be well recommended as a convenient, easily read, and easily understood chart, to be used as a guide in a study of the stars which are visible to the unaided eye.

Signpost to the Stars, by F. E. Butler. (George Philip & Son, Ltd., 32 Fleet Street, London. 1s.)

This is a small pamphlet of thirty-two pages giving diagrams and descriptions of the more familiar of the celestial objects. It is one of several similar publications which have appeared in England as a consequence of the more or less permanent "blackout." It is of convenient pocket size, and consequently the user may easily have it available at all times.

The first two paragraphs of the introduction are quoted below. The first shows clearly that, whatever destruction may have been wrought, a definite sense of humor remains. The second gives the author's idea of the purpose for which the pamphlet is intended.

"Most of this booklet was written in an "Anderson" steel shelter in the autumn of 1940, while overhead the German Luftwaffe was doing its best to demoralize London. During an occasional venture into the open to verify observations, the regulation forty ounces of "tin hat" was the accessory, not the conventional telescope. It may be as well to assure the reader that the star patterns of bursting A.A. shells were not included in the diagrams in error; the stars and constellations shown are only those whose identity has long been established.

"Here then is a guide to the stars for the veriest novice, who cannot be bothered with right ascension and declination, and whose imagination cannot aid him to recognize constellations by the conventional classical figures. Possibly war-

time darkness and Civil Defense duties have created a new awareness of the stars, and for the moment the amateur observer asks nothing more than to know the names of prominent groups and individuals, and how to recognize them."

New Spectrum Chart Published

Of special interest to teachers of physics, chemistry, and electrical engineering, and to practicing engineers and scientists, is a new seven-color wall chart of the entire electromagnetic spectrum recently published by the Westinghouse Research Laboratories.

Approximately 30 by 40 inches in size, the chart is printed on heavy white cloth, and is bound at top and bottom in 3/8-inch black-enameled wooden rods. Two metal rings are attached to the top binding rod for convenient hanging.

Every part of the electromagnetic spectrum, of practical significance, is analyzed in detail. Emphasis is placed on uses of each kind of radiation. Spectral terms are carefully and simply defined in a special glossary.

Each chart is packed in a substantial closed cardboard tube, and is sent postpaid. The price is $2.00. Orders should be sent to Publications Section, 6-N-17, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Publications Received.—The publishers of POPULAR ASTRONOMY hereby acknowledge the receipt of the following named publications and express their great appreciation of the courtesy shown on the part of those who have sent them.

Contributions from the Lick Observatory:

No. 1. "The Rotation of the Spiral Nebula Messier 33," by N. U. Mayall and L. H. Aller.

No. 2. "Distribution of Mass in the Spiral Nebulae Messier 31 and Messier 33," by A. B. Wyse and N. U. Mayall.

No. 3. "Considerations Regarding Cometary and Interstellar Molecules," by P. Swings.

No. 4. "The Spectra of Ten Gaseous Nebulae," by A. B. Wyse.

Communications from the David Dunlap Observatory:

No. 8. "Aluminizing Tank for the David Dunlap Observatory," by R. K. Young.

No. 9. "A Semiregular Variable in Messier 4," by Helen B. Sawyer.

Publications of the David Dunlap Observatory:

No. 11. "The Light Curves of Four Variable Stars in the Hercules Cluster Messier 13," by Helen B. Sawyer.

No. 12. "Variable Stars in the Globular Cluster Messier 80," by Helen B. Sawyer.

Contributions from the Mount Wilson Observatory:

No. 659. "The Spectrum of BD +11° 4673 During the Years 1937-1941," by Paul W. Merrill.

No. 660. "Absolute Dimensions of the Wolf-Rayet Star and the Expanding-Envelope Hypothesis," by O. C. Wilson.

No. 661 and 662. "The Spectrographic Orbit of the Companion to Rigel," "The Spectrographic Orbit of 42 Capricorni," by Roscoe F. Sanford.